Evolution of the Advanced Manufacturing Trades Training Program and the Advanced Technology Academy

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Sandia National Laboratories

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Abstract

In an effort to recruit and retain skilled workers in the Manufacturing Science and Technology Center (14000), an innovative and highly diverse team at Sandia National Laboratories and the U.S. Department of Energy joined with concerned community constitutents, such as Albuquerque Technical Vocational Institute and the Albuquerque Public Schools, to offer mentoring and on-the-job training to qualified students in high schools and community colleges. Now, within several years of its inception, the educational program called the Advanced Manufacturing Trades Training Program is a model in the community and the nation, while enabling Sandia to have valuable trained and skilled employees to meet its national mission and workforce demands.

Acknowledgements

We would like to acknowledge the core team that got this program started:

- Jane Poppenger and Doug Abrams (Sandia Labs, 14186);
- Phil Gallegos and Lucille Justice (Sandia Labs, 14112);
- Sharon Ortiz and Eva Mueller (Sandia Labs, 03531);
- Dave Leyba, Daniel Archuleta, and Robert Kaneshiro [Metals Trade Council (MTC) representatives] for their vision and creativity to look beyond the internal system to develop a new training program;
- Steve Benavides and Joe Rodman [Albuquerque Technical Vocational Institute (TVI) directors] who assisted in aligning our training needs with their programs, setting up the co-op, and providing the first recruits; and
- Leo Reddy and C.J. Schroll of National Coalition for Advanced Manufacturing (NACFAM) for assisting in the implementation of skill standards and providing criteria from which we could benchmark our program.

Special thanks to:

- Milton Baca, Essel Baca, and Tom Daly (West Mesa High School) for their initiative, cooperation, and commitment to students;
- Mike Stanton and Linda Sink (Albuquerque High School) for their innovation and dedication;
- Bob Hall (TVI) for his responsiveness and incisive insight; and
- U.S. Department of Energy/Defense Program Office of University Partnerships for focusing on critical skills-development programs that have a lifelong impact on the national laboratories, students, and their futures.

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Nomenclature

ACT	Academic College Testing
AFL-CIO	American Federation of Labor-Congress of Industrial Organizations
AMTTP	Advanced Manufacturing Trades Training Program
APS	Albuquerque Public Schools
CAD/CAM	Computer-aided design/computer-aided manufacturing
C-OTSS	Core Occupational and Technical Skill Standards
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
DP	Defense Programs
EEO/AA	Equal Employment Opportunity/Affirmative Action
ES&H	Environment, safety, and health
ESS&H	Environment assurance, safety, security, and health
FTE	Full-time equivalent
LTE	Limited-term employee
LTTTE	Limited-term Trades Trainee Employee
MEMS	Micro Electro-Mechanical Systems
MEST	Mutual Education of Skills Training Phase of the AMTTP
MSSC	Manufacturing Skill Standards Council
MTC	Metal Trades Council
NACFAM	National Collation for Advanced Manufacturing
NIMS	National Institute for Metal-Working Skills
NSSB	National Skill Standards Board
QAT	Quality Action Team
PWB	Printed wiring board
R&D	Research and development
Sandia	Sandia National Laboratories
SIP	Student Internship Program
SNL	Sandia National Laboratories
S-OTSS	Specialty Occupational and Technical Skill Standards
STA	Senior technical asssociate
STT	Specific Trades Training Phase of the AMTTP
TA	Technical associate
TTP	Trades Training Program
TVI	Albuquerque-Technical Vocational Institute
WFO	Work for Others

I. The Program

In 1999, the number of skilled tradespersons needed to fulfill Sandia National Laboratories' mission was declining, and the traditional apprentice programs, designed to provide replacements, had been terminated due to cost. Consequently, Sandia formed a team to design and develop a new program maximizing usage of community resources, existing Sandia programs, and a new approach to providing and monitoring on-the-job training that produces fully qualified tradespersons at a greatly reduced cost.

In addition to Steve Benavides and Joseph P. Rodman of the Albuquerque Technical Vocational Institute (TVI), team members from Sandia included:

- Douglas Abrams   14186-2,
- Ronnie Albers   14186-1,
- Vanessa Anderson   14186-2,
- Dan Archuleta   14181-2,
- Margarito Crespin   14112-1,
- Phil Gallegos   14112,
- Louis A. Gonzales   14112,
- Lucille B. Justice   14112,
- Robert Kaneshiro   102651,
- Paul Lemke   14100,
- David Leyva   14186-1,
- John McAuliffe   03532,
- Sharon Ortiz   03531,
- Eva Mueller   03531,
- Steff Perea   14112,
- Jane Poppenger   14186-1,
- Debbie L. Rimbert   14112-1,
- Thomas M. Souther   14186-2, and
- Charles Townsend   14186-2.

The new Advanced Manufacturing Trades Training Program (AMTTP) provides Sandia management with much greater control than the former apprentice program. From the student's perspective, this program provides an opportunity to experiment with career possibilities and gain valuable work experience without having to make an up-front, life-long commitment. This innovative endeavor results in a training program that delivers fully qualified, skilled tradespersons in selected disciplines for these key customers: Phil Gallegos, Department Manager, 14112; Bob Poole, Department Manager, 14171; Tom Simpson, Department Manager, 14181; and Paul McKey, Department Manager, 14186.

Represented skilled trades employee training is regulated by contract between Sandia and the Metals Trade Council (MTC). It was necessary that a formal proposal for the AMTTP be prepared in time for contract negotiations in 2002. That need was met, and AMTTP is included in the current contract. Other key stakeholders include:

- Steve Benavides and Joe Rodman of TVI,
- Tom Daly of Albuquerque Public Schools (APS)—West Mesa High School,
- Norm DeMeza, SNL Center Director of 14100,
- John McAuliffe of Labor Relations,
- Sharon Ortiz of SNL's Student Internship Program (SIP),
- Bill Sena of the MTC,
- Dominique Foley Wilson, DOE DP Critical Skills Development Programs,
- Trainees, and
- Current skilled tradespersons.

Figure 1. Phil Gallegos, Manager 14112; Dominique Foley Wilson, DP Critical Skills Development Programs; and Bonnie Jackson, West Mesa High School Technology Coordinator visit a Metals class in the Academy.

A. Sharing Standards with National Organizations

A key part of the AMTTP is adopting and developing skill standards to clearly identify those specific capabilities needed to be successful as a tradesperson. Consequently, the standards developed in this program will be shared with national organizations such as National Collation for Advanced Manufacturing (NACFAM) and National Institute for Metal-Working Skills (NIMS).

It is significant to note that the AMTTP's success today to train, hire, and maintain a skilled workforce in advanced manufacturing started with a need to preserve business. It evolved into a program refined to meet these needs, and is now worked in conjunction with other programs (such as the Advanced Technology Training Academy) aimed at helping high school students have better futures due to tailored math and science

programs. Today, both the AMTTP and the Advanced Technology Training Academy are continuing to enjoy success and being held up as national models.

In the beginning, the AMTTP had seven specific requirements, outlined in further detail in Table 1.

TABLE 1: INITIAL PROGRAM ACTIVITIES AND MEASUREMENTS

	REQUIREMENTS ON THE ACTIVITY		MEASUREMENT	
M, D, C*	Requirement/factor/issue description.	Applicable to which customer(s)?	Measurement.	Target
7, M	Train qualified skilled tradespersons.	P. Gallegos, B. Poole, T. Simpson, and P. McKey	Number of skill standards.	Describe all trade tasks.
			Number of key activities.	Describe all critical functions.
			Trainee progress.	Meet 5-year target value.
1, M	Cost.	N. DeMeza	Training cost.	<< apprentice program.
2, D	Get AMTTP into MTC contract.	J. McAuliffe	Proposal delivery date.	In time for negotiation.
3, D	Increase Metals Technology graduates.	TVI	Number of graduates.	Reverse downward trend.
4, M	Total training time.	P. Gallegos, B. Poole, T. Simpson, and P. McKey	Time to complete program.	No longer than 5 years.
5, M	Improved customer control.	P. Gallegos, B. Poole, T. Simpson, and P. McKey	Number of times trainee hired.	3.
6, M	Work doesn't interfere with school.	SIP	Hours worked during school.	Limit of 25 hours.

* Indicates <u>M</u> for mandatory, <u>D</u> for desirable, and <u>C</u> for compliance.

Since the initial AMTTP concept in 1996 to the present, the AMTTP has yielded numerous measurable benefits to all participants, particularly in developing occupational/technical skill standards and key activities within skilled-trades disciplines. In terms of product or service quality, these standards describe specific tasks and their associated performance expectation, which form the measurement foundation for the AMTTP.

B. Adopting Skill Standards at Sandia Labs

Skill standards (see Appendix) were first adapted at Sandia for advanced manufacturing in Electronic Fabrication and Machining/Mechanical Measurements. These standards were based primarily on national skill standards from NACFAM. Skill standards combine to describe critical work functions and key activities and are evaluated using a performance-based scale. This scale is used to both evaluate the progress of individual trainees and, when averaged over all trainees, to evaluate the AMTTP itself.

By early 1998, adoption of the appropriate NACFAM skill standards expanded to the Machining discipline, thus raising the target. In 1999, the Machining discipline began to incorporate National Institute for Metal-Working Skills (NIMS) standards; however, these two sources did not fully meet Sandia-specific, training-development needs. Because Advanced Manufacturing at Sandia has a research and development (R&D) focus, it requires a greater breadth and depth of knowledge and skills compared to national skill standards, which identify manufacturing-production skills with a narrower breadth and depth of knowledge and skills.

With this identified gap, the Sandia-specific skill standards for Advanced Manufacturing are under development. As seen in Fig. 2, by the end of 1999, SNL was nearing the initial goal of being able to fully describe our skilled-trades work in Electronic Fabrication and Machining. However, the goal again moved with the addition of a new technology (laser fabrication) in Electronic Fabrication. The target is expected to move upward as new technologies and completely new discipline areas are added. These skill standards are used as both training guides and as evaluation tools.

Number of Identified Knowledge and Skills
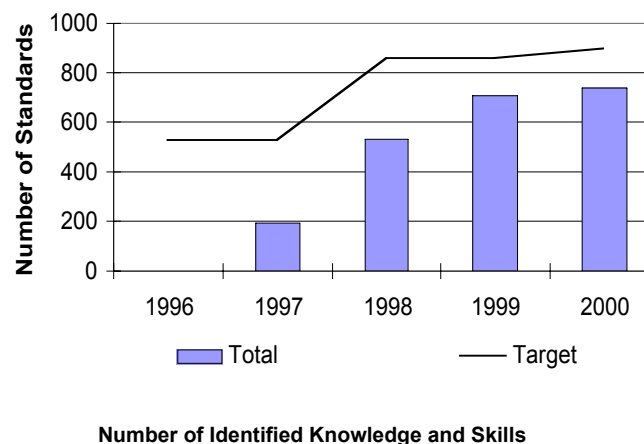
Figure 2. Skill standards development.

C. Sandia's Program Benefits Technical Vocational Students

Not only has our program been successful at Sandia, but TVI's Metals Technology graduates also have benefited. In the past, TVI had experienced a downward trend in the number of graduates in both the certificate and the two-year Associate Degree programs. Now that has changed for the better, especially from partnering with Sandia's Student Internship Program (SIP). Consequently, the benefits for everyone involved have been numerous and far-reaching. It has truly been a "win-win" situation for Sandia, TVI, and the students.

In early 1997, the Manufacturing Science and Technology Center began discussions with TVI during the developmental stage of its AMTTP. Then and now, Sandia requires trainees entering the second phase of the AMTTP to have achieved an Associates degree in their discipline. Therefore, TVI used this information in its student interactions and recruiting.

As seen from Fig. 3, TVI's objective has been met; the declining trend in graduation has been reversed. As an added benefit to this stakeholder, enrollment in TVI's technology program (the program covering Electronic Fabrication) has increased 15%.
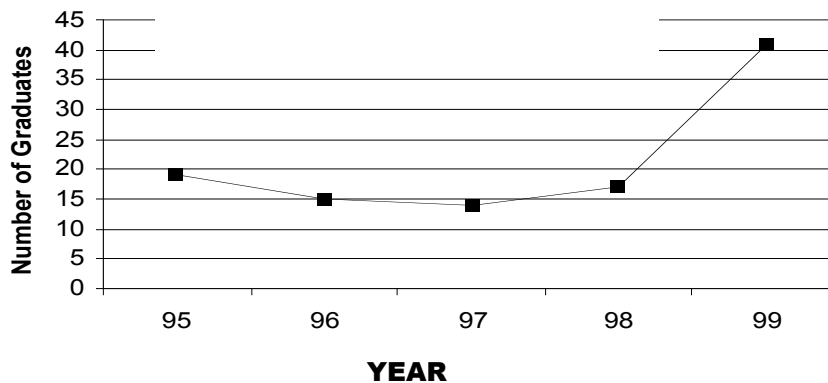
Figure 3. TVI metals technology graduates.

In 2001, an Advanced Manufacturing career pathway was designed to target high school students with high aptitudes in science and math, provide the necessary classroom education, ensure their successful graduation from TVI, and offer on-the-job training for them to perform at the skilled-trades level. This pathway takes approximately five years to complete—the same length of time needed to complete Sandia's former apprentice program. (However, an AMTTP trainee can complete the program in less time.)

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D. Developing Skill Standards

When new standards were needed, the AMTTP team developed them in partnership with journeyman-level, skilled tradespersons in the craft, process engineers, and instructional designers from Corporate Training and Development. Skill standards are comprised of concentrations, critical-work functions, and key activities. Each concentration is described by a series of critical-work functions, which are the major responsibilities of work within a concentration. Each critical-work function is described by a series of key activities, which are the major tasks involved in carrying out a critical-work function within a skilled-trades discipline. The six major skill standard concentrations that describe major areas of manufacturing work at Sandia are:

- **Manufacturing Development and Engineering**
  where skilled tradespersons design, develop, and implement a process for prototype development, and assess product and process design for manufacturability.
- **Logistics and Inventory Control**
  where skilled tradespersons plan and control the movement and storage of materials and products in the manufacturing system.
- **Production**
  where skilled tradespersons setup, operate, monitor, control, and improve manufacturing and storage of materials and products in the manufacturing system.
- **Quality Assurance**
  where skilled tradespersons ensure that the manufacturing system meets quality-system requirements, as defined by business and Sandia's customers.
- **Environment Assurance, Safety, Security, and Health (ESS&H)**
  where skilled tradespersons ensure that the manufacturing system meets ESS&H requirements.
- **Maintenance, Installation, Testing, and Repair**
  where skilled tradespersons ensure that maintenance of the manufacturing system fulfills customer and business requirements, including installing and repairing equipment on the manufacturing floor.

Moving from a time- to a performance-based, training-evaluation system required creating performance indicators as qualitative-measurement functions for the critical work functions. Each critical work function has a unique performance indicator, which is information on how to determine when someone is performing all key activities within that critical work function competently. The key-activity concept (when combined with a proficiency scale) provides a useful progress-tracking tool. Thus, critical work function proficiency is a three-point spectrum in which trainees have gained:

- An awareness or understanding of the critical work function through study or experience,
- The skill to effectively perform an observable task with occasional guidance, and

- The ability to competently apply learned skills to new and concrete situations with minimal guidance is illustrated in Fig. 4.
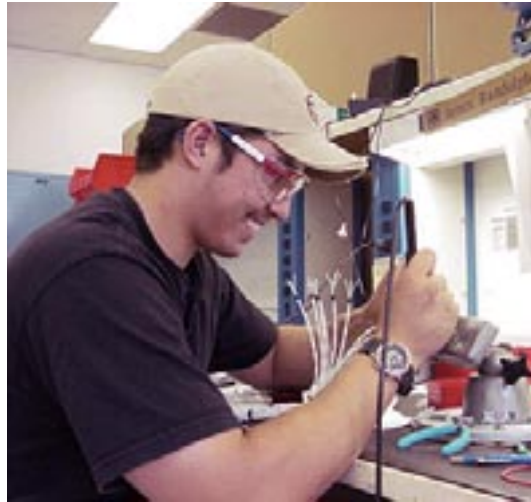
Figure 4. James Randolph, Advanced Technology Academy graduate and Electronic Fabrication trainee, proves the success of the AMTTP skill standards by proficiently applying assembly knowledge and skills.

For a given critical work function, a trainee might be expected to be knowledgeable at the end of the first year, be able to demonstrate competence at the end of the second year, and be proficient at the end of five years. The final expected proficiency level for a given critical work function maps directly to what is needed to operate as a fully qualified tradesperson. By imposing a numerical scale on the proficiency spectrum and setting progress targets, evaluation of both the AMTTP and the trainees is possible.

The Electronic Fabrication Department first experimented with this concept. Because of its success there, the concept is being deployed to other AMTTP disciplines. Figure 5 shows that most critical work functions in Electronic Fabrication were completely defined by FY00. A new laser-fabrication technology was added and became a new skill area that wasn't taken into account by developing key-activity descriptor/associated skill standards.
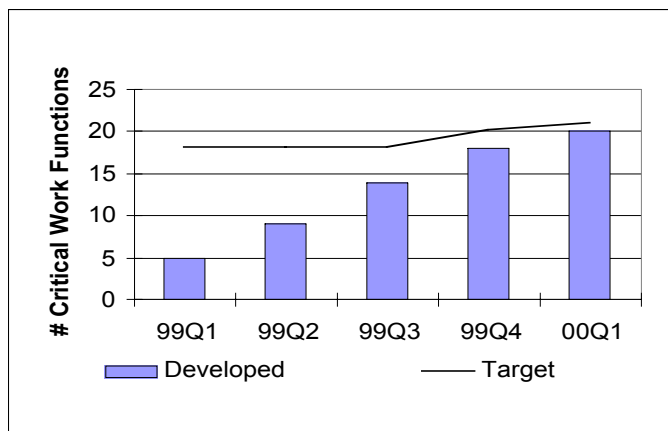
Figure 5. Critical work function development.

To save time and costs, the goal (completion of the AMTTP) is for trainees to meet rather than exceed the target. Figure 5 shows that the program was on track. Target values shown in Fig. 6 were established by the AMTTP team through consultation with people practicing the craft at the journeyman level. As trainees progress, both the critical work functions evaluated, along with proficiency expectations, increase. This approach to monitoring trainee progress proficiency (based on skill standards) is without precedent; thus, there is no comparative information available.
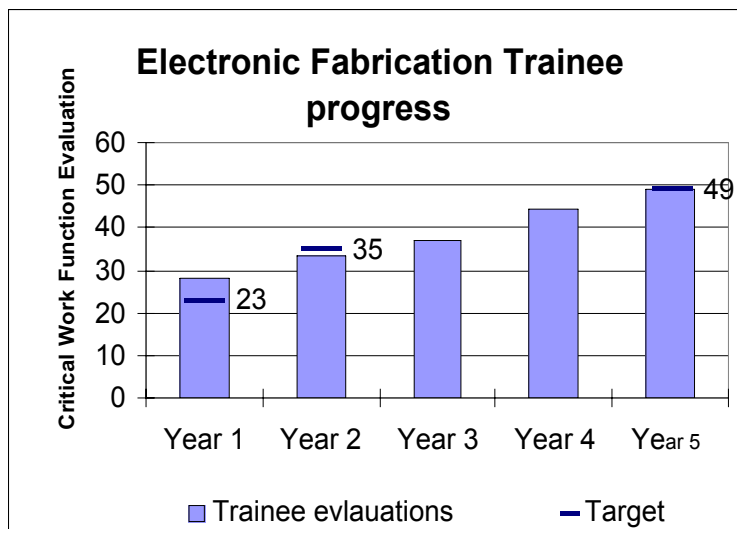
Figure 6. Electronic fabrication trainee progress.

E. A Performance-based Program

The AMTTP provides a scaffolded learning approach with performance-based training evaluation on three levels. When a trainee masters a skill (i.e., achieves the proficiency required by the skill standards), the trainee advances to the next training level. Upon successful completion of all three levels of training and graduation from community college, the Trades Trainee meets or exceeds the entry-level requirements for full-time hire as a tradesperson at Sandia. Once hired as a full-time employee, the individual may participate in Corporate University-Based Education Programs to advance his or her education. This Advanced Manufacturing Career Pathway is illustrated in Fig. 7.
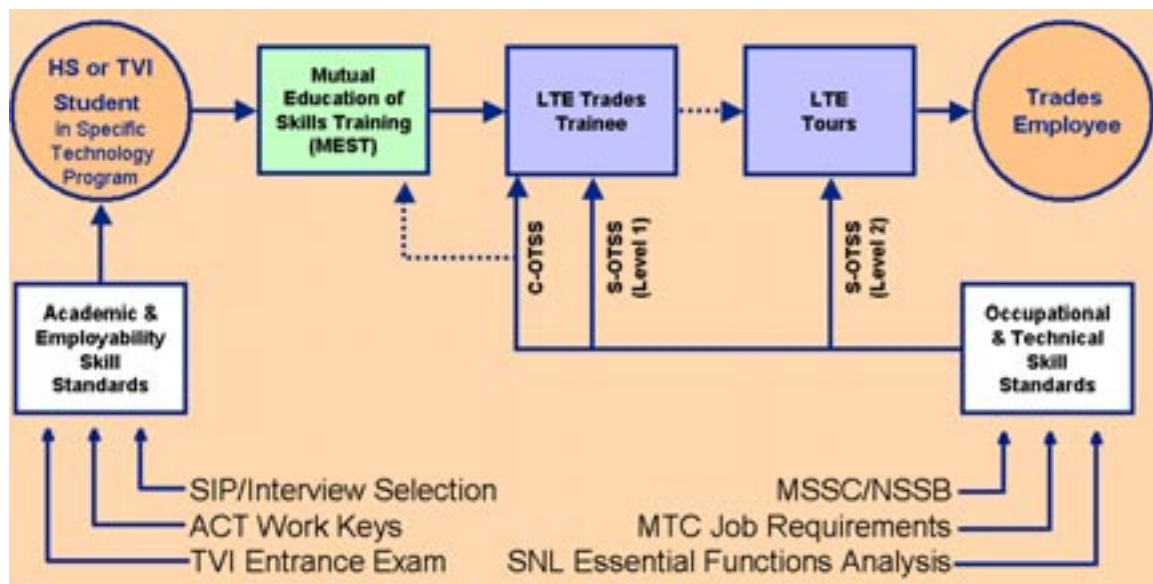
Figure 7. Overview of the Advanced Manufacturing Career Pathway.

AMTTP Trades Trainees are, in effect, hired three times:

- **Mutual Education of Skills Training (MEST) Phase**
  where the first two years focus on academic and employability skills and is implemented through a cooperative program with community colleges. Students work part-time at Sandia when school is in session and full-time between sessions and during holidays. The MEST phase provides the trainee with an opportunity to experiment with his/her career choice and provides Sandia with an opportunity to evaluate the trainee's potential for success at skilled trades. At the end of this period, successful trainees are selected to interview for next phase.
- **Specific Trades Training Phase**
  where Sandia-specific situated and contextual learning is delivered through on-the-job training to Limited Term Trades Trainee Employees (LTTTE). Occupational and technical skill standards, which break down complex skills into key activities, provide the foundation for this specialized performance-based

training. When the LTTTE has successfully completed this second phase, he/she has the opportunity to apply for full-time employment.

- **Full-time Trades position**
  where the tradesperson may specialize in a particular area of expertise and also advance his or her education through Corporate Training and Education programs.

These three "hiring" milestones are based on valid and reliable skill-standards criteria, which provide both the trainee and Sandia with the opportunity to evaluate the probable success of the match as illustrated in Fig. 8.

Figure 8. Nicole Trino and Victoria Fowler from the Advanced Technology Academy at West Mesa High School learn teamwork skills in Mr. Drake's Metals class.

F. MEST and the AMTTP

MEST resulted from a cooperative effort between TVI and Sandia to assist and encourage advanced manufacturing students through a pilot training program in electronic fabrication, machining, and mechanical measurements at SNL's Manufacturing Science and Technology Center. The MEST phase, together with the Center's Specific Trades Training (STT) phase, form the AMTTP. Since its formation in 1996, MEST has grown into a formal cooperative workforce-development program among the Manufacturing Science and Technology Center, the MTC, the Sandia Student Internship Program, Science and Technology Outreach, TVI, other New Mexico community colleges, and the Albuquerque Public Schools (APS). Then it was aimed at training tradespersons in the electronic, metrology, machining, and materials-science disciplines of advanced manufacturing.

Today, MEST identifies and recruits qualified students who are motivated to successfully complete an associate degree in numerous advanced-manufacturing disciples from an accredited program. Students complete degree courses related to their selected discipline at New Mexico community colleges, including TVI, San Juan Community College, and Luna Vocational-Technical Institute. In Sandia's Manufacturing Science and Technology Center, students receive on-the-job training in specific advanced manufacturing disciplines as illustrated in Fig. 7.

During our program, trainees made notable progress. Figure 9 shows the first "class" of the Advanced Technology Academy graduated in July 2000. These Academy graduates have been accepted by both their peers and SNL management as fully qualified to enter the AMTTP at Sandia.

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Figure 9. The first "class" of Advanced Technology Academy graduates at West Mesa High School in 2000.

Sandia is concerned that MEST students have enough time to devote to school and their studies to ensure success in the AMTTP. MEST is implemented under the guidelines of SIP, which limits students to 25 hours of work per week during times when school is in session. During holidays and school vacation, MEST students are encouraged to work 40-hour weeks to gain more experience and earn greater income.

AMTTP's purpose is to produce highly skilled tradespersons in Electronic Fabrication, Machine Skills, Mechanical Measurements, and Materials Science disciplines to fill in Sandia-specific skills gaps in these disciplines. AMTTP benefits everyone by:
- Following valid benchmarked skill standards,
- Providing jobs,
- Increasing community involvement, and
- Forming a base of skilled technical workers.

These discipline-specific training programs arose from a team formed to develop and implement a comprehensive training program to replenish our aging and depleted manufacturing-trades workforce in the shortest time possible and at the lowest cost possible. The training program was designed to follow former apprenticeship programs'

instructional strategies by providing theoretical foundations, instruction-based skills, and practical on-the-job training to produce qualified tradesperson-level employees.

Formed in January 1997, the team evolved into the Trades Training Program Review Committee (TTPRC) with three subcommittees. When the team was formed, an agreement between the MTC council and 14000 management established a December 1998 deadline to have a training program proposal ready for review. This proposal then was taken into negotiations on August 1999. The first stage of the project was to define program parameters. The team consisted of 14000 personnel, MTC, Labor Relations, TVI administrators, and SIP representatives. They met monthly to determine how to use the existing infrastructure to hire students and to determine hiring criteria. In addition, the team met to discuss the logistics of a co-op program and the amount of time needed to complete it. This phase of the program was to be called MEST. The second phase of the Trades Training Program was to be called Specific Trades Training Phase in which Limited-Term Trades Trainees (LTTTE) would be hired from qualified MEST graduates and provided training for a maximum of three years, see Figs. 4 and 10.

Figure. 10 David Calkins, LTTTE in Materials Science, displays the product of the autoclaving process in the Plastics Laboratory at Sandia.

The most important requirements were to ensure that, at the end of the training period, the graduating students would have the following:

- Possess the full range of proficient skills and knowledge necessary to deserve the title Trades, and
- Be a fully productive member of the Manufacturing Science and Technology Center and Sandia Labs.

In 2000, Sandia made a decision to change the then-known "Trades Training Program" (TTP) to the "Advanced Manufacturing Trades Training Program" (AMTTP), which scoped the program's focus toward the newer manufacturing technologies, such as microfabrication and use of computer-controlled lasers. The team used existing documentation from the former apprenticeship program to ensure that valuable skills would continue to be taught. In addition, team members and Corporate Training and Development Consultants participated in further defining expert-trade skills by using the NACFAM SkillSystems process, mentioned earlier. At this same time, the team reported their findings to TVI constituencies for use in their development of Academic College Testing (ACT) Work Keys, a career-focused student learning system aligned to workforce needs, see Fig. 11.

Figure 11. Monico Lucero, TVI Graduate and LTTTE, programs the coordinate measurement machine in Sandia's Mechanical Measurements Laboratory to inspect a satellite part for an internal customer.

As part of the MEST phase, TTP provided TVI students technical training in advanced manufacturing during the summer. Summer hires were exposed to various manufacturing skills and activities, such as:

- Blueprint reading;
- Use of hand tools (benchwork);
- Design of setups, tools, and fixturing for mills, lathes, and measurement equipment;
- Using CAD/CAM systems;
- Metal-removal techniques; and
- Use of inspection equipment.

TVI provided students with the technical curriculum and assisted in identifying potential candidates. At Sandia, the U.S. Department of Energy (DOE) Defense Programs (DP) Critical Skills Development Programs implemented the Advanced Training Academy pilot project at West Mesa High School to develop interest in manufacturing. Student participants, who successfully demonstrated an interest in furthering their education in advanced manufacturing, provided an external pipeline of qualified employment candidates into Sandia as illustrated in Fig. 12.

Figure 12. The 2001 Advanced Technology Academy freshman class with Academy Director Tom Daly (kneeling), Phil Gallegos (Manager 14112), and Dominique Foley Wilson, coordinator of DOE DP Critical Skills Development Programs (back row).

Sandia's SIP enrolled students, provided orientations, and tracked corporate-required training. The Manufacturing Science and Technology Center provided the instructors, equipment, and laboratories in which these students worked. The students were trained in the basics of manufacturing technologies and exposed to advanced-manufacturing processes.

The main areas of training were in the Mechanical Measurements, Machining, and Electronic Fabrication disciplines. Students were teamed with experienced tradespersons and challenged in product fabrication of the latest engineering designs. After the MEST phase, students were rotated through specialty trades training tours, where they gained skills to ensure proficiency at the skilled-trades level. (These tours eventually evolved into the Specific Trades Training phase of the AMTTP.) The length of this phase was typically three years and two years for the MEST phase. Upon program completion, students were more marketable to the manufacturing community and to Sandia's Manufacturing Science and Technology Center.

To afford opportunities to a larger population of students, this training program concept, which evolved over time through joint efforts, was shared with the business community. Thus, AMTTP became a world-class educational program utilizing existing capabilities and best practices.

II. Background

A. End of Cold War Brought End to Apprenticeship Programs

Not only did the end of the Cold War in the late 1980s bring about a paradigm shift in terms of world power, it had drastic consequences to Sandia's weapons work. The U.S. Department of Defense (DoD) demand for product dropped dramatically. This had a negative impact on Sandia's former manufacturing-apprenticeship program, which was both an external and internal pipeline program that ran from the 1960s to late 1980s.

Once the Cold War was over, all Sandia apprenticeship programs ended as budgets ran out. Nothing replaced these apprenticeship pipeline programs to bring in needed skilled employees. Sandia tried to hire qualified employees externally, however, they lacked the required skills. See Fig. 13 for additional information.
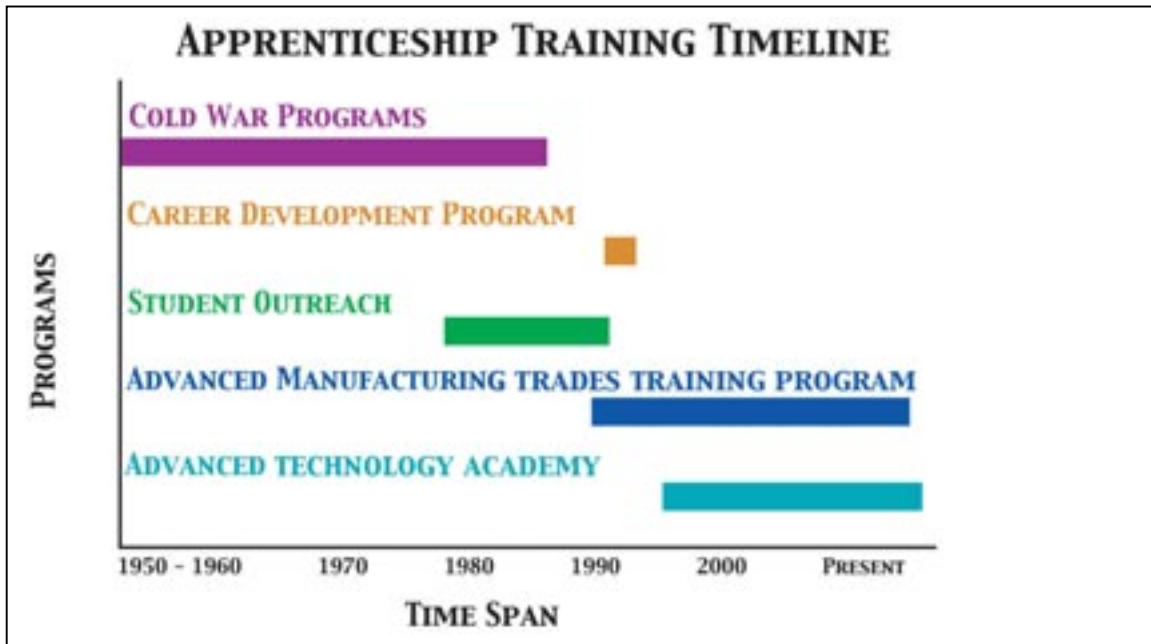
Figure 13. Apprenticeship training timeline.

B. Drivers for New Training Program

In the late 1980s, there were several drivers indicating a need to have a program to replace the former apprenticeship pipeline. The work environment was changing with downsizing, restructuring, and re-engineering. Sandia's workforce was aging, with retirements imminent. Tradespersons were making career movements from trades to technologists. In addition, technical organizations were experiencing manpower shortages. Not able to hire qualified people, the Manufacturing Science and Technology Center (14100) went from approximately 300 to 100 tradespersons. Projections based on attrition and retirement rates predicted that fewer than 20 tradespersons would be working in three to four years. The Manufacturing Science and Technology Center faced several critical questions: How can we remain a viable organization? Are the manufacturing disciplines important to the laboratories' mission?

The Electronic Fabrication Department (formerly Department 2412) faced declining trades personnel and was unable to fill those positions with qualified trades personnel. The Electronic Apprentice Program that served as a feeder to supplement trades personnel for Electronic Fabrication hadn't accepted or trained workers for the preceding two years—while Department 2412's needs for such trained personnel were being unmet and could have jeopardized its ability to meet customer demands.

In 1993, Sandia's customers from Defense Programs (DP) and Work for Others (WFO) programs projected a continuing critical need for Electronic Fabrication tradespersons. Sandia was losing members of this group at an alarming rate to technical associate (TA)

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and senior technical associate (STA) positions elsewhere in the company. Therefore, Sandia believed it was desirable to fill the need for these employees with critical skills by retraining existing Sandia employees, rather than by hiring from outside. This program was enthusiastically supported by the leadership of the Metal Trades Council, Sandia Labor Relations, and the Equal Employment Opportunity/Affirmative Action (EEO/AA) organization.

Customer input to Sandia advised that either SNL make the changes to have the necessary trained tradespersons or the customers would set up their own capabilities for design-to-application R&D prototyping. In May 1993, the Electronics Fabrication Department (2412) developed a two-year Electronics Fabrication Training for on-roll employees (who met entry-level training requirements) to change career goals and/or progress to a trades-level position if they weren't at that level. The training began as a one-time opportunity to meet business needs. At this time, Phil Gallegos, Electronic Fabrication Department Manager, became involved with an advisory committee and TVI to work on establishing an educational program with tradespersons in electronics. As a result of this cooperation, student trainees were brought into the Manufacturing Science & Technologies Center through the SIP.

C. Partnering with High Schools and the Community College

Sandia began to look at existing processes to bring in students into Sandia to train them for advanced manufacturing. Phil Gallegos began reaching out, as did Dominique Foley Wilson (of SNL's Science and Technology Outreach Program), who began working to interest students in science and technology under the auspices of the DOE Critical Skills Development Programs. At that time, the DOE decided to align educational programs with the national-security mission regarding advanced manufacturing. Institutionalized and strategic plans were developed after cooperative talks with Sandia's technical line organizations.

Following the need to redefine Education Outreach to align with stockpile-stewardship missions, Dominique and Phil, with a need for trained personnel, began working together in 1996. Together, they worked on pipeline issues, with various Sandia managers, union representatives, and educators. A pilot pipeline program for educating advanced-manufacturing careers was conceived. West Mesa High School, part of the APS, was selected as the pilot site and enthusiastically embraced the pipeline program to potentially mitigate its high school dropout rates.

While work was under way with the high school, Sandia formed a team to work with the local community college, TVI, to explore ways to train workers for SNL's Electronics and Machining. Because TVI needed to recruit students, the high school program (called the Advanced Technology Academy) also would function as a pipeline for recruiting students into the community college. This partnering between Sandia, the APS, and TVI would help create a self-sufficient, lean program to train students—helping both students and the businesses better control their own destinies.

D. Benefits from Community Partnerships

The Advanced Technology Academy's success prompted program expansion to include Albuquerque High School. Staring with 21 teens, the program has grown quickly; average grade-point average of the students, who first applied to the internship program, was 2.5 and today the average is 3.86. Over 200 students have enrolled for the 2002-2003 academic year. Academy students are encouraged to continue their technical education and apply for the AMTTP.

TVI revamped its existing technology and trades curricula to meet Sandia's needs and was able to increase its matriculation. In the past, only 6% of TVI's incoming freshman class were recent high school graduates. In 2000, the APS began to offer concurrent enrollment so students can fulfill TVI requirements and earn credits toward college while they're still in high school. To further improve their curricula, TVI and the APS created Career Clusters in an initiative to help align public education with workforce needs. Now, TVI has created a unique and important educational niche for a community college by offering students opportunities for career growth in good jobs and the pursuit of future education.

Another key outcome was an understanding that TVI could educate students instead of Sandia, which avoided sustaining expensive training costs associated with extensive skills training for employees over the five-year training period covered by the AMTTP.

This partnership among community resources and Sandia has received recognition on the national, local, and corporate level as a best-practices model (see Appendix A-2 and A-3).

III. A Closer Look at School Partnerships

A. Educational Partnerships

One success measure of the of the Manufacturing Science and Technology Center's training programs is its collaborations with schools and related educational programs, particularly those locally within APS, such as the Advanced Technology Academy and Photonics Academy. According to the APS superintendent in a June 2001 letter, Sandia recognized the need for a new "pipeline" of qualified future employees. A DOE DP grant funded the initiation of the Advanced Technology Academy, which engages students in math, science, and technology while creating an external pipeline into the workplace, particularly Sandia (see Appendix A-3).

First instituted at West Mesa High School and later at Albuquerque High School, this successful program could be expanded to include all district high schools. As of mid-2001, the first group of 11 Academy students, who started the program at West Mesa in 1997, continued their education at TVI in various technology-related fields. Sandia had hired 5 graduates, and 6 trainees were completing their studies at TVI.

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According to APS, current data indicates that 50 percent of the public-school students in New Mexico are at risk of not graduating from high school. "This is a sobering statistic," the superintendent noted. "The Academy is designed to, above all, reduce the student dropout rate. In so doing, the Academy is succeeding in engaging students early on, as a group, in a support structure that cultivates a balance relationship with teachers and excites them about hands-on, inquiry-based math, science, and technology-related curriculum." He emphasized that the Advanced Technology Academy—in cooperation with Sandia's Advanced Manufacturing for Education program (see Appendix)—"does not pigeonhole students. Rather, it provides numerous career pathways that increase their options and opportunities for post-secondary education and meaningful employment with significantly higher compensation and benefits." Career pathways available to participating students include computer applications, computer-aided design (CAD), web design, machining and materials processing, atomotive and transporation technologies, and pre-engineering math and science.

Further information on Sandia's Advanced Manufacturing Trades Training Program and the Advanced Technology Academy is provided in the Appendix A-4 and A-5.

IV. Further Improvements with Skills, Standards, and Best Practices

A skill standards-based system was implemented to remain consistent with industry practices and the national direction in workforce, and to provide training that is relevant, consistent, and measurable, The training was modeled after a process developed by the National Coalition for Advanced Manufacturing Coalition's (NACFAM) SkillSystems. Advantages to implementing this system included:

- Access to information and databases gained from national research, benchmarking, and best practices of leading companies;
- Build organizational involvement by using the incumbent workforce to help define standards;
- Establish specific and measurable criteria;
- Provide training that is consistent, valuable, and free from personal bias;
- Install a system for continuously updating skill and training needs; and
- Provide a set of requirements that can be cleanly communicated to education and training programs both in companies and in schools.

A. NACFAM and Best Practices

The AMTTP team wanted a method for identifying the skills necessary to perform the work in their respective areas and examined NACFAM's SkillStandards as a viable systematic approach. In 1997, the Manufacturing Skill Standards Council (MSSC), see below, was funded by a U.S. presidential initiative to economically support the manufacturing workforce. The MSCC was jointly operated by the American Federation of Labor-Congress of Industrial Organizations (AFL-CIO)/NACFAM during the time it

took to finalize standards in 2001 by identifying and defining national skill standards for manufacturing.

NACFAM's strategy is to provide leadership in building national policies, programs, and services in the fields of workforce skill-standards development, public-private technology R&D partnerships, and technology deployment to small- and medium-sized companies. In addition, it serves as a bridge builder between industry and nonprofit organizations that offer value-added serviced to manufacturers, such as:

- Community and technical colleges,
- University research centers,
- Federal laboratories,
- Manufacturing extension centers and services, and
- Small business development centers.

During the process to determine national skill standards, representatives from both Sandia and the DoD sat on committees to encourage the continued development of the National Skill Standards Systems for advanced manufacturing. This effort is aimed at increasing U.S. productivity in manufacturing, an improved economy, and more technology transfers. This effort has been extremely important in establishing national-level skill standards that can be used for benchmarking.

Academic institutions can utilize the national academic and employability skill standards for curricula development, which meet workforce needs. In the past, these institutions found it difficult not only determine and refine workplace skill standards, but also to identify the specific knowledge and skills required for entry level into the workforce. Since these skill standards provide a valid and reliable foundation for education and training curricula development, public schools and community colleges can provide a standardized workforce having the required occupational and technical skills to perform proficiently on the job.

In addition, Sandia can assist academic institutions by consulting with educators on curricula development aligned to workforce needs and benchmarked to national standards. This has been a critical development because now Sandia and academic institutions finally can clearly communicate workforce needs through the common language of skill and performance standards.

NACFAM not only has been supportive of the efforts undertaken by Sandia and its collaborators in this effort (see Appendix A-2), but currently is developing a national accreditation system to give evidence that trainees going through an accredited program—such as the Sandia/TVI effort—can qualify for national accreditation in their fields.

B. Involvement with the Manufacturing Skill Standards Council

To achieve its goals, Sandia has benefited from its involvement with the Manufacturing Skill Standards Council (MSSC), whose members are comprised of leading companies, unions, and leading national, state, and regional organizations with a direct institutional stake in the improvement of U.S.-based manufacturing. MSSC members must have an extensive network into their respective stakeholder communities (companies, labor unions, employees, teachers, students, parents, etc.). An important role that members from Sandia and the DoD played in working with the MSSC was to be a key influence to develop skills standards in advanced manufacturing that kept a focus on R&D.

In May 2001, the MSSC launched the nation's first skill standards set for manufacturing as the first major step toward developing a nationwide system of skill standards, assessments, and certification as envisioned in the National Skill Standards Act of 1994. More than 4,000 front-line workers, 700 companies, 300 experts, and 30 facilitating organizations participated in the development of the MSSC skill standards. The goal was to create skill standards that apply to all sectors of the manufacturing industry, in six areas (such as in production and quality assurance) as well as to identify core knowledge and skills common to all concentration areas.

C. Benchmarking Sandia-Specific Skill Standards for Advanced Manufacturing: Taking a Quality Approach to Training

In 1997, the Manufacturing Science and Technology Center began work with NACFAM and MSSC to adopt skill standards documentation and an associated systematic process. Realizing the vast scope of this process, in 1998, the AMTTP team turned to Corporate Training and Development, Technical and Compliance Training, for expertise and assistance (see Appendix A-4 for the AMTTP Training Analyses Management Plan). From 1998 to 2002, Carla Forrest (lead) and Jodi Case, Senior Corporate Training and Development Consultants, worked with the AMTTP, MSSC, NACFAM, TVI, SIP, and APS constituencies to develop and implement a strategic direction for a cooperative workforce-development program benchmarked to national and Sandia-specific skill standards in advanced manufacturing.

The purpose of Corporate Training's involvement was to conduct the appropriate analyses required to determine and benchmark skill standards for the AMTTP in three disciplines:
- Electronic Fabrication,
- Machine Skills/Mechanical Measurements, and
- Materials Science.

Two sets of Sandia-specific skill standards were developed for advanced manufacturing:
- Academic and Employability Skill Standards, and
- Occupational and Technical Skill Standards.

The Academic and Employability Skill Standards list critical entry-level skills applicable to all advanced manufacturing trades positions in Sandia's Manufacturing Science and Technology Center (see Appendix A-4). They:

- Provide a base foundation for learning and training activities,
- Establish hiring criteria for both AMTTP trainees and trades employees at Sandia, and
- Guide continuous education and training for current and future trades workers in advanced manufacturing.

The AMTTP's Occupational and Technical Skill Standards for each of the described disciplines identify both core and specialty occupational and technical skills sets. The Core Occupational and Technical Skill Standards are applicable all Trades Trainees in the Manufacturing Science and Technology Center (regardless of discipline) and describe the basic occupational and technical knowledge skills required for work performance across a broad range of occupations.

Core knowledge and skills include:

- Environmental,
- Safety,
- Security,
- Health,
- Business policies and procedures, and
- Manufacturing processes.

Specialty Occupational and Technical Skill Standards are applicable to the specific departments and disciplines within the Center and describe the skills, knowledge, and performance unique to a specific job or occupation, subindustry, technology, or a specific skills-training program.

The analyses were used to determine curricula requirements to establish an enduring skills-training program for the Manufacturing Science and Technology Center. In 2000, the success of skill-standards system was reflected in the hiring of a full-time Trades Training Program Specialist, Thomas Souther, who continues to advance the AMTTP's quality approach to training.

Further information on Sandia's Advanced Manufacturing Pipeline Trades Training Program and the Advanced Technology Academy is provided in the Appendix A-4 and A-5.

V. Ties with Next Generation Economy Initiative

Sandia's work in developing a skilled technical workforce and helping academic institutions develop curricula now is linked to a new program in New Mexico called the Next Generation Economy Initiative. This program implements a growth strategy for the local economy and attempts to convert it into a technical goldmine. In this initiative, there are six specific industry clusters in central New Mexico that offer the greatest potential to drive the economy into the new century.

Clusters are geographic concentrations of industries and the private and public institutions that support them, such as universities, national laboratories, financial institutions, workforce development programs, and governments. They are identified as:
- Artisan Manufacturing,
- Biomedical and Biotechnology,
- Electronics,
- Information Technology and Software,
- Optics and Photonics, and
- Tourism.

Sandia, the Air Force Research Laboratory, TVI, the University of New Mexico, and other major New Mexico institutions are involved in this organized effort. Sandia is taking a leadership role in the microsystems cross-cluster initiative, which is a hybrid of four of the clusters—electronics, optics, photonics, biomedical/biotechnology, and information technology.

In April 2002, NACFAM joined with industry leaders, federal laboratory directors, and association executives for a roundtable discussion of industry-federal laboratory R&D issues. This effort to examine changes in the U.S. innovation system was organized by the Technology Administration at the U.S. Department of Commerce. Discussions were held about national laboratories having mission requirements, while serving industry's needs for productivity and competitiveness. One of the most important outcomes of this gathering occurred when the Commerce Deputy Secretary closed the meeting by mentioning President Bush's call for serious attention to education and workforce issues.

In response, the president of NACFAM cited the partnership between Sandia and West Mesa High School as a best-practice example of a successful laboratory-industry educational partnership, which is focused on developing the next generation of manufacturing workers.

A. Next Generation Economy Initiative: TVI's 2000-2004 Carl Perkins Project

Inspired by the state's initiative mentioned earlier, TVI's 2000-2004 Carl Perkins Project (see Appendix) incorporates its career technical-educational components to lead to five multi-level, high-wage "career cluster" programs. It also aims to have "support structure"

programs to ensure student success in the career clusters. Underlying both the career clusters and support structure are five programs:

- Advanced Manufacturing,
- Biotechnology,
- Construction,
- Artisan Manufacturing,
- Information Technology, and
- Tourism and Hospitality.

This endeavor is being funded by a U.S Department of Energy (DOE) grant. Skill standards were instrumental in helping TVI's Workforce Training Center identify areas to align, improve, and create both the career and technical-educational components for this important project.

VI. Summary and Conclusions

Sandia's efforts to educate students and train its future workforce have met with resounding success. Below are some examples.

- As of February 2002, NACFAM began citing the AMTTP as an example of a best practice model in effective implementation of industry-led national skill standards. NACFAM has commended both Sandia and the DOE for this ground-breaking program, see Appendix A-2.

- The metrics have provided valuable information, particularly the number of students who have been hired in the program and the many who have successfully moved to LTTTE status. The program is very popular with TVI, West Mesa High School, and Albuquerque High School. In addition, Sandia received many offers during the year to bring news of its program via numerous job fairs across the state.

- Sandia's innovative efforts with the AMTTP have not gone unnoticed. The team has received the following awards: 2002 Lockheed Martin Employee Recognition Award, the 2001 Sandia President's Quality Award (Silver), and a 2000 Center 14100 Team Performance Award (Gold).

- Sandia's Advanced Technology Academy innovatively packages curriculum into a four-year academy in such a way that students have viable options and emerge with sufficient math and science to go straightaway into the workplace, to TVI, or to college.

- NACFAM and the DOE are so impressed by the Advanced Technology Academy that it is being proposed as a model to plant and DOE contractors in other facilities across the country.

A. Teamwork Led to Successes

This project could not have been completed without teamwork. This team consisted of members from Sandia staff, Sandia MTC Trades, TVI, and APS. Without the support and commitment from the members, the success of this project would be questionable, at best. MTC ratification of this program would not have been possible without the commitment of its representatives on this team.

TVI's willingness to listen to Sandia's educational needs and assist in the recruitment activities was a key element in the implementation of this program. Student Internship Program (SIP) representatives were essential in helping spread the word about opportunities in our Center to high school students, who could eventually help fill our ranks. Our ability to work with the representatives from Human Resources, who administer the SIP, and their willingness to be flexible enough to adapt to some of our needs greatly helped reduce administrative costs associated with a program such as this. The cooperation and consultation of Corporate Training and Development, Technical and Compliance Training, was essential in the development of valid and reliable Sandia-specific skill standards in advanced manufacturing.

Over the years, the Trades' skills and expertise associated with our Center have supported numerous projects and programs throughout Sandia. After the discontinuation of the very successful Apprentice program, we began to lose a lot of our skills and talents to other organizations through attrition. Had this program not been implemented to train new Trades with the skills to carry out the caliber of support they have given Sandia, many organizations would be without the support they have always been able to count on.

This program benefits the Manufacturing Science and Technology Center directly by introducing new talent through a viable training program that supports the external pipeline.
- Our costumers across the lab benefit by having their R&D efforts and prototype work supported at the highest skills level.
- The students benefit because they have a good solid career.
- The community benefits by aligning community-college curricula to local business and workforce needs, which in turn support the New Mexico economy.

B. AMTTP is a Model Platform

The AMTTP is a model platform for solving the critical national shortage of skilled workers. It benefits new advanced technology programs, such as Photonics and Micro Electro-Mechanical Systems (MEMS). As of June 2002, the Manufacturing Science and Technology Center had 36 MEST students and 35 LTTTE in the AMTTP, see Fig. 14. In addition, 7 AMTTP graduates have been hired as full-time Sandia employees.

Figure 14. Kim Archuleta, TVI Graduate and LTTTE in Materials Science, performs thin film deposition in support of research and development for Center 14100

C. Future Direction

Both the Advanced Manufacturing Trades Training Program (AMTTP) and the Advanced Technology Academy face an exciting future. Important external recognition is being given for the AMTTP because it meets key reportability requirements and provides recognition for graduates. For tradespersons, having an apprenticeship traditionally is the highest form of recognition. As of late 2002, both the U.S. Department of Labor and the New Mexico Department of Labor were competing to register the AMTTP program—a great measure of its success! Once an agency is selected, the AMTTP for Machining and Mechanical Measurements will be registered, followed in FY04 by the AMTTP for Electronics Fabrication and the Material Science.

The future also is expected to see the expansion of the program within Sandia rather than being confined to 14000. At the same time, Sandia plans to pursue specialized certifications such as a machining certification by NIMS. Within the next two years, the entire AMTTP program is expected to be certified by NACFAM—which would make Sandia Labs the first in the nation to have a truly model national program.

The program also is expanding its recruiting to Northern New Mexico students from both the San Juan Community College in Farmington and Luna Vocational-Technical Institute in Las Vegas. Students from Santa Fe High School also will benefit due to the expansion of the Advanced Technology Academy to the state's capitol city. In the meantime, talks are underway to explore expanding the program outside the state to Texas (El Paso Community College), Arizona (Gateway Community College in Phoenix), and Minnesota (Lake Superior Community College).

In addition, TVI is pursuing the possibility of a "2+2" program with New Mexico Tech University (New Mexico Institute of Mining and Technology) or the University of New Mexico to enable students to transfer 100% of their credits to a Bachelor's degree at the university, which would be a significant benefit to encourage students to pursue higher education.

"What started out strictly as a program to address Sandia's internal needs within each group has grown tremendously beyond addressing Sandia's needs to increase technologist staffing," noted Thomas (Tom) Souther, AMTTP coordinator. "We can't bring people in fast enough to address our needs and their needs."

Appendix

A-1. Electronic Fabrication Training Program Agreement

Below is a copy of the agreements signed by program participants in 1994.

I agree to the conditions of the training program and understand the importance of my participation and completion of all requirements of this program. Only after successful completion of the program will I be classified as a Trades employee in Electronic Fabrication Department 2412. Failure to complete the program will result in being reclassified to my job status prior to starting the program. I will not receive any compensation for any course requirements taken out of normal working hours. During the training program, I will be evaluated on a trimester basis that runs according to the TVI schedule. I agree that a "C" grade or better must be maintained for class work and an "M" (meets requirements) rating or better for job training. I will schedule my vacation accordingly to minimize interference with my training and be responsible to report to work when classes are not schedule.

I understand the conditions specified above. _____

<div align="right">Trainee</div>

Approved by _____

<div align="right">Date</div>

A-2. National Coalition for Advanced Manufacturing Letters of Support

Chairman
Eric Mittelstadt
FANUC Robotics North
America, Inc.

Co and Founder
Leo Reddy
NACFAM

President
Egils Milbergs
NACFAM

Secretary
[illegible]
ESC

Treasurer
J. David Fialka
Federal Association

Board Of Directors

Brian Cadena
Adtec Technology

Dan F. Cadena
The Association for
Manufacturing Excellence

John Dumas
National Center for
Manufacturing Sciences

Richard Lilly
Lilly Software
Associates, Inc.

Barry Moore
Chandler Technology

Rusty Patterson
Asplund

Richard Sawson
Red Hat

Lois M. Dumas
National Association
State Universities &
Land Grant Colleges

Nancy Baalman
Intel Corporation

Al Romig
Sandia National
Laboratories

Joseph Bhiltze
Industrial Modernization
Center & PA Industrial
Resource Center

Jordan West
Oak Ridge Center for
Manufacturing Technology

February 19, 2002

Mr. J. Leonard Martinez
Sandia National Laboratories
P.O. Box 5800
Dept. 14000, M.S. 0149
Albuquerque, NM 87185
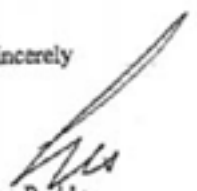
Dear Lennie:

I wanted you to be aware of my letter (copy enclosed) to Secretary Abraham concerning the success of the Advanced Technology Academy, which I recently visited in Albuquerque. This program is providing a pipeline of skilled technicians for the needs of both Sandia National Laboratories' Advanced Manufacturing Facility and other manufacturers in New Mexico.

NACFAM will cite this program as an example of a best practice model in the effective implementation of industry-led national skill standards. We will also draw upon some of the experts within the Academy to help develop programs like this in other parts of the country.

Sandia Labs and the Department of Energy are to be commended for their support of this ground-breaking program.

Sincerely

Leo Reddy
CEO and Founder

Cc: Copy of Letter to U.S. Secretary of Energy

NACFAM
National Coalition for Advanced Manufacturing

Chairman
Ron Mitchell
AMVIC Relation North
America, Inc.

Co- and Founder
Lee Keble
NACFAM

President
Lyle Milner
NACFAM

Secretary
E.J. Netfek
ESG

Treasurer
J. David Foche
Anshul Automation

Board Of Directors

Brian Cadele
Adapt Technology

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The Association for
Manufacturing Technology

John Dugato
Advanced Center for
Manufacturing Sciences

Richard Lilo
Lilo, Behann
Associates, Inc.

Kara Mauer
Chrvello Technologies

Rusty Patterson
Raytheon

Roland Turner
Ford Motor

Lois W. Freeze
National Association
State Directors of
Local Govt Colleges

Motor Seabuch
Auto Corporation

Al Spong
Sandia National
Laboratories

James Skillan
Industrial Midwestern
Center & PA Industrial
Resource Center

Joann West
Oak Ridge Center for
Manufacturing Technology

February 15, 2002

The Honorable Spencer Abraham
Secretary of Energy
1000 Independence Avenue, S.W.
Washington, DC 20585

Dear Secretary Abraham:

I would like to bring to your attention a program, the Advanced Technology Academy, located in Albuquerque, New Mexico, that is successfully providing the kinds of skilled technicians needed by the Advanced Manufacturing Facility at Sandia National Laboratories as well as those needed by other manufacturing companies with plants based in New Mexico. This program, based on National Skill Standards, represents an effective pilot for the entire nation.

Last December, I personally visited the schools in Albuquerque participating in this program and met with teachers and students. I was encouraged by the enthusiasm of the students, who were clearly turned on by the creativity inherent in the practical application of advanced, IT-based technologies to making tangible products. I was also impressed with the curriculum and its alignment with industry-led National Skill Standards. For the past decade, NACFAM has led the development of National Skill Standards for the manufacturing workforce, so I am familiar with best practices nationally in standards implementation.

The Advanced Technology Academy is certainly a best-practice example. Established in 1996, it provides a pathway for high school students into technology-intensive careers in high performance manufacturing. Beginning at the high school level, the Advanced Technology Academy packages a four-year curriculum, including hands-on paid internships, which ensure student success. I understand the Academy will graduate 200 students a year by 2005.

The Academy is jointly funded with approximately equal support from the Student Internship Program at Sandia National Laboratories and the Critical Skills Development Program at the Department of Energy's Office of Defense Programs. The Critical Skill Development Program supports initiatives like the Advanced Technology Academy designed to provide a pipeline of new students trained in technology areas appropriate for the skill needs of the Laboratories.

In this case, students enrolled in the Academy become qualified candidates for Sandia's Advanced Manufacturing Trades Training Program (AMTTP). Advanced Manufacturing is a key element in the Stockpile Life Extension Program and in modernization of the weapons complex. This area is suffering high attrition as a result

of changing demographics, job competition and an aging workforce at the Laboratories.

The Advanced Technology Academy program is meeting Sandia needs and those of other manufacturers in New Mexico such as General Mills, Philips, Intel, Air Force Research Lab, Motorola, Lockheed Martin, CVS, Honeywell, as well as a number of smaller companies. This academy program constitutes a model that can be used nationwide to provide U.S.-based manufacturers with skilled technicians needed to keep pace with rapidly changing technologies.

During my visit, I was also impressed with the leaders of the Advanced Technology Academy program: Tom Daly, West Mesa High School; Mike Stanton, Albuquerque High School; Dominique Foley Wilson and Phil Gallegos, Sandia National Labs; and Bob Hall, Albuquerque Technical Vocational Institute.

For its part, NACFAM will work to raise national awareness of this innovative model, spearheaded by the Department of Energy and Sandia National Laboratories.

Sincerely,

Leo Reddy
CEO and Founder

cc: Senator Domenici
        Senator Bingaman
        Representative Wilson
        Dr. Everet Beckner, NNSA
        Dr. Paul Robinson, Director, Sandia National Labs
        Dr. Alton Romig, Vice President, Sandia National Labs
        Dr. Tom Hunter, Defense Programs, Sandia National Labs

A-3. Albuquerque Public Schools Letter of Support

ALBUQUERQUE PUBLIC SCHOOLS

Bradford Allison, Ph.D.
SUPERINTENDENT

June 13, 2001

Dear APS Colleagues, Members of the Legislature, and Members of the Business Community:

As superintendent of the Albuquerque Public Schools, I've been extremely fortunate to have worked shoulder to shoulder with many remarkably talented and capable people within the district and the business community and at the state level. I know that these exceptional people welcome the opportunity to contribute to improving life in New Mexico in countless important areas and especially for the benefit of our children.

The most urgent message that we in New Mexico and, indeed, the entire nation have been hearing in recent years is that our public schools are in trouble and our children are not globally competitive in math and technology-related curricula. The conscientious efforts of New Mexico teachers, as well as the sincere and generous contributions of our political and business partners, have already made a positive difference. However, additional creative programs and resources are needed if we are to provide our children with the most comprehensive and appropriate K-12 education possible. Our children need a relevant education that prepares them to pursue higher education goals or enables them to start meaningful internship employment with high-tech businesses.

In addition to the well-publicized urgency of revitalizing K-12 education programs, government agencies and businesses are now voicing strong concerns about the scarcity of graduates, at high school and post-secondary levels, for future employment in technology-related areas. The expressed need for a prepared, technology-literate workforce can no longer go unaddressed.

Sandia National Laboratories recognized the need for a new "pipeline" of qualified future employees several years ago. Acting on that need, with Department of Energy/Defense Programs funding, SNL created the *Advanced Technology Academy*, a program to engage students in math, science, and technology and, at the same time, ensure a stable pipeline of potential technical employees. The *Academy*, which was first instituted at West Mesa High School and is a proven success, is now also a strong presence at Albuquerque High School. In upcoming years, the *Academy* will be expanded to include all district high schools. The first group of eleven *Academy* students, who started the program at West Mesa High School in 1997, continued their education at Albuquerque TV-I in a variety of technology-related fields. SNL has since hired five and six are completing their studies at TV-I. Each year of the *Academy's* presence in the school has seen an increase in student participation, engagement, and graduation.

I would like to emphasize that the *Advanced Technology Academy*, in cooperation with SNL's *Advanced Manufacturing for Education* program, does not pigeonhole students. Rather, it provides numerous career pathways that increase their options and opportunities for post-secondary education and meaningful employment with significantly higher compensation and benefits. Career pathways available

P.O. Box 25704
ALBUQUERQUE, NEW MEXICO
87125-0704

AN EQUAL OPPORTUNITY EMPLOYER

40

to participating students include computer applications, computer-aided design (CAD), web design, machining and materials processing, automotive and transportation technologies, and pre-engineering math and science.

Current data show that approximately 50 percent of students in New Mexico are at risk of not graduating from high school. This is a sobering statistic. The *Academy* is designed to, above all, reduce the student drop-out rate. In so doing, the *Academy* is succeeding in engaging students early on, as a group, in a support structure that cultivates a balance relationship with teachers and excites them about hands-on, inquiry-based math, science, and technology-related curriculum.

I'm writing to you now because we have a unique and precious opportunity to engage our students, particularly those who have been historically underrepresented in technology-related fields, in a proven program that meets their educational and career-planning needs, enhances our education system, and satisfies a serious employment need for SNL and many local technology firms. By partnering, we can construct and expand an outstanding education program that, first and foremost, meets the career-planning needs of our children and, at the same time, grows a well-prepared technical workforce.
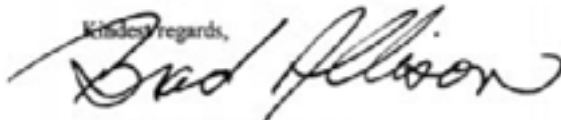
As the *Advanced Technology Academy* has been nurtured along in recent years, I have met with SNL representatives and *Academy* teachers. I can tell you that all associated with the *Academy* are dedicated to growing it into a district-wide program that serves the needs of the community and can be used as a model throughout the state and the nation.

To promote the program, SNL created a jazzy, soft-rap video called *Put a Little Science in Your Future*, which they are pleased to say has won nine national and two international awards. The video and colorful companion brochure and PowerPoint presentation are readily available for your viewing and use. In addition, I encourage you to visit their attractive, very informative web site at http://www.sandia.gov/HighTechHighSchool/.

I invite you to add your name to the ever-growing list of partners of the *Advanced Technology Academy*. Together, we can build a community-sponsored education model that provides our children with the best technology-related education possible. I urge you to contact the Sandia National Laboratories DOE Programs Coordinator, Dominique Foley Wilson, at 844-1315 or dfoley@sandia.gov.

One last thought: when you take action to begin your partnership with the *Academy*, please let me know. I'm excited about the incredible opportunities for growth and creativity that will occur when our greater community works together for our children. Thank you for taking the time to read this letter and, especially, for taking the first step toward involvement.

Kindest regards,

Brad Allison, Superintendent
Albuquerque Public Schools

A-4. Advanced Manufacturing Trades Training Program Training Analyses Management Plan
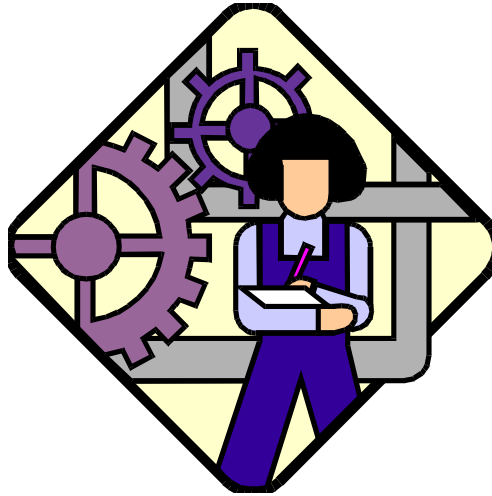
Carla M. Forrest

Corporate Training and Development

Original: March 2000

Rev 6: January 2002

Advanced Manufacturing Trades Training Program

Training Analyses Management Plan

Introduction

Mutual Education of Skills Training (MEST) is a cooperative workforce development program among Sandia National Laboratories' Manufacturing Science and Technology Center, the Metal Trades Council Union (MTC), the Student Internship Program (SIP), Science and Technology Outreach, Albuquerque Technical Vocational Institute (TVI) and other New Mexico community colleges, and the Albuquerque Public Schools (APS). It is aimed at training tradespersons and technologists in the electronic, mechanical, machine, and materials science areas of advanced manufacturing.

MEST identifies and recruits qualified students who are motivated to successfully complete an associate degree in one of these manufacturing disciplines from an accredited program. Students complete degree courses related to their selected manufacturing discipline at New Mexico community colleges, including TVI. In Sandia's Manufacturing Science and Technology Center, students receive on-the-job training in the specific advanced manufacturing disciplines.

The purpose of the Advanced Manufacturing Trades Training Program (AMTTP) is to produce highly skilled tradespersons in Electronic Fabrication, Machine Skills/Mechanical Measurements, and Materials Science, which fill Sandia-specific skills gaps in these disciplines. This training program is a partnership to benefit both Sandia and the community by developing skill standards, providing jobs, increasing community involvement, and forming a base of skilled technical workers.

Scope of Project

The purpose of this project is to conduct the appropriate analyses required to determine and benchmark skill standards for the Advanced Manufacturing Trades Trading Program in three disciplines: Electronic Fabrication, Machine Skills/Mechanical Measurements, and Materials Science. The analyses will be used to determine curricula requirements, which will be used as the foundation for an enduring skills training program.

Objectives and Methods

- **Define project requirements.**
  Introductory meetings with key stakeholders and Electronic Fabrication, Machine Skills/Mechanical Measurements, and Materials Science subject matter experts (SMEs) will be attended.

- **Assess current requirements for AMTTP.**
  Interviews will be conducted with key stakeholders and SMEs.

- **Assess current community services (TVI/APS/SIP/Sandia Science and Technology Outreach) programs.**
  Introductory meeting/tour with TVI personnel will be attended.
  Interviews will be conducted with TVI personnel and students.
  Interviews will be conducted with Sandia Employment/Staffing personnel involved in the Student Intern Program (SIP).
  Interviews will be conducted with Sandia Science and Technology Outreach Program personnel.
  Document review will be conducted on all applicable documents;
  a reference list will be created to include all documents reviewed and/or used in the training analyses.

- **Define AMTTP pre-requisites.**
  Introductory meeting/tour with TVI personnel will be attended.
  Interviews will be conducted with TVI personnel and students.
  Interviews will be conducted with Sandia Employment/Staffing personnel involved in the Student Intern Program (SIP).
  Interviews will be conducted with key stakeholders and SMEs.
  Document review will be conducted on all applicable documents.

- **Identify and document duties and tasks for 3 disciplines (Electronic Fabrication, Machine Skills/Mechanical Measurements, and Materials Science) through document reviews, observations, and interviews.**
  Document review will be conducted on all applicable documents.
  Information review will be conducted on all applicable electronic databases.
  Observations will be conducted for each discipline
  Interviews will be conducted with SMEs and expert performers (EPs) for each discipline.

- **Detail duty areas and tasks for each discipline by identifying and benchmarking skill standards (knowledge, skills, and abilities) for each task.**
  Knowledge – information recalled or recognized in order to successfully perform an activity.
  Skill – proficiency or dexterity in the use of hands or body to correctly, properly, safely, and adequately perform a series of actions at a given standard.
  Ability – natural or acquired facility in a specific activity; physical or mental potential to perform a task element.

- **Validate skill standards for each discipline.**
  Under the facilitation of a training analyst, focus groups of subject matter experts and expert performers in each discipline will review, refine, and concur on the knowledge, skill, and abilities (skill standards) for that discipline. After concurrence on the skill standards, approval of task

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inventories and skill standards sets for each discipline will be obtained by the Joint Trades Sub-Committees.

- **Conduct gap analyses between the AMTTP pre-requisites and the skill standards identified for the 3 disciplines.**
  Gap analysis identifies the required (critical and crucial) knowledge and skills that are the foundation for mandatory training.

- **Administer DIF-T surveys.**
  DIF-T (Difficulty/Importance/Frequency/Transfer) surveys will rate the characteristics of the tasks in skill standards sets and will aid in identifying training recommendations for each discipline. The surveys will be completed by focus groups. The results will be analyzed to identify AMTTP curricula recommendations.

- **Develop summary report and obtain approval of the AMTTP analyses.**
  A narrative report containing the purpose, objectives, methods, key points, outcomes (including customer identification), and recommendations for curriculum development, program administration, and program evaluation will be developed and routed to the Phillip Gallegos (14112), AMTTP Coordinator.

Resources

Two subject matter experts (SMEs) and one expert performer (EP) from each discipline (Electronic Fabrication, Machine Skills/Mechanical Measurements, and Materials Science).

Responsibilities

Phillip Gallegos, AMTTP Coordinator, is responsible for final review and approval of the Advance Manufacturing Trades Training Program analyses.
Phillip Gallegos, AMTTP Coordinator, is responsible for identifying and providing the required subject matter experts and expert performers for each discipline.
Carla Forrest, Senior Corporate Training and Development Consultant, is responsible for the supervision and completion of the training analysis project.
Jodi Case, Senior Corporate Training and Development Consultant, is responsible for assisting the completion of the training analysis project.

Milestone Dates

Define project requirements .... 1/19/00 – 2/29/00
Assess current requirements and community services...................................... 1/19/00 – 5/30/00
Create management plan and obtain approval.. 2/15/00 – 3/15/00
Identify subject matter experts and expert performers..................................... 1/19/00 – 3/15/00
Define AMTTP pre-requisites.. 2/16/00 – 6/15/00

Present assessment to Joint Trades Committee   6/00

Conduct and validate training analyses for 3 disciplines .... 6/15/00 – 6/28/02
      Electronics Fabrication .... 6/15/00 – 9/15/01
      Machine Skills.. 12/14/00 – 3/15/02
      Mechanical Measurements[*] .... 4/01/01 – 6/15/02
      Materials Science /Ceramics and Glass... 9/11/00 – 9/27/02

**Obtain approval of the Task Inventories and Skill Standards sets
by the Joint Trades Sub-Committees..11/15/01 – 6/28/02**

Conduct gap analyses for the 3 disciplines .... 11/15/00 – 3/15/02
Plan and implement Electronic Fabrication Training Program........................... 9/15/01 – 6/28/02
Plan and implement Machine Skills Training Program .... 3/15/02 – 6/28/02
Plan and implement Mechanical Measurements Training Program.................... 3/15/02 – 8/29/02
Determine training recommendations.. 9/15/01 – 6/28/02
Determine guidelines for program administration.. 11/01/01 – 2/28/02
Develop and obtain approval of summary report .... 7/15/02 – 9/27/02
Consult with Phillip Gallegos on MTC presentation..08/02

Points of Contact

If there are any questions concerning the Trades Training Program analyses project,
please contact Carla Forrest at 284-6255 or <cmforre@sandia.gov>.

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[*] Framework and prerequisites developed during Machine Skills analysis.

A-5. Advanced Manufacturing Trades Training Program Career Pathways
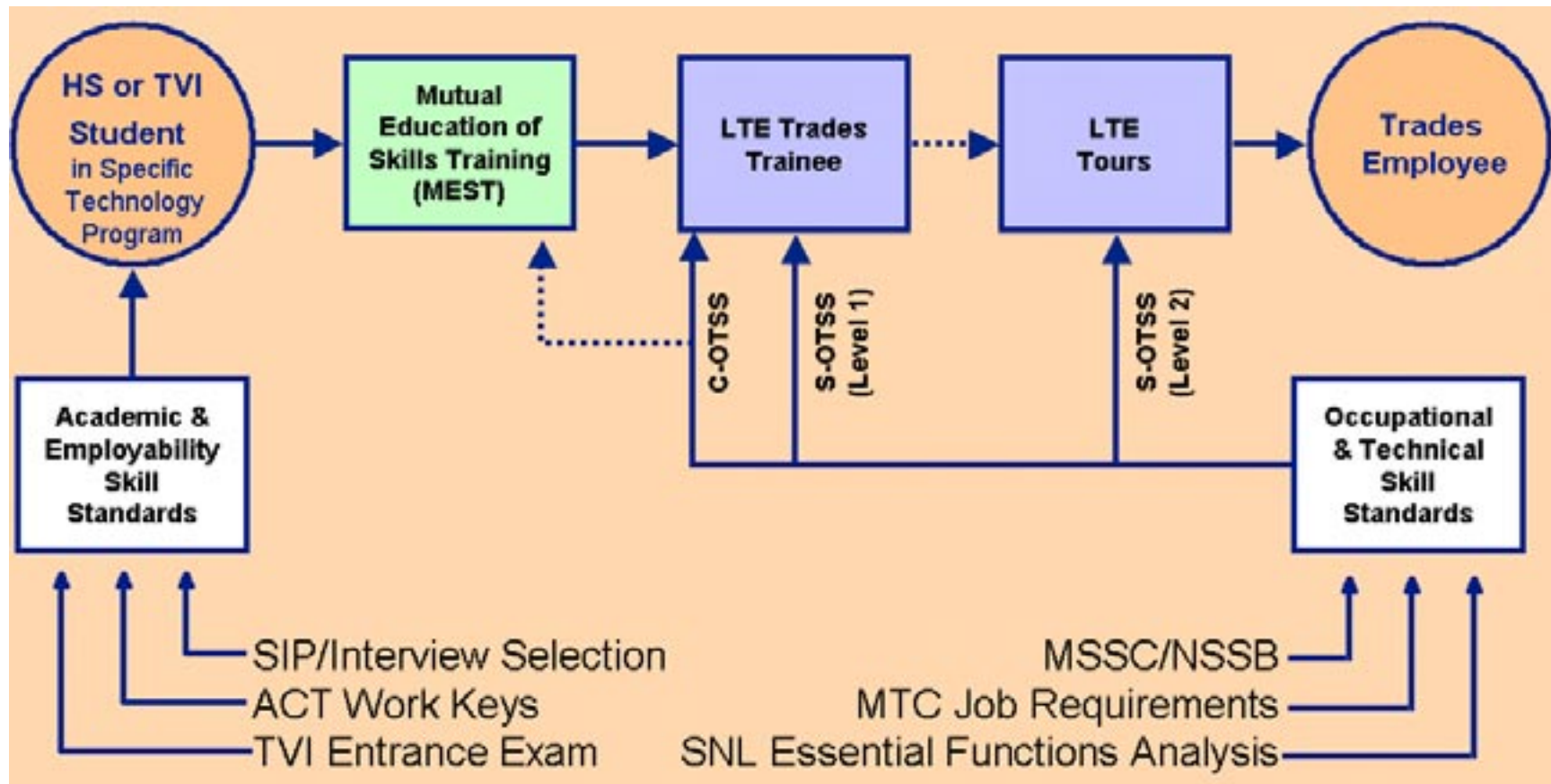
A-6. Advanced Manufacturing Trades Training Program Framework for Curriculum Development from MSSC Benchmarked Skill Standards

Skill Standards Description

Skill Standards	Abbr.	Description
Academic & Employability	AESS	· Academic knowledge and skills associated with the academic disciplines of reading, writing, mathematics, and science · Employability knowledge and skills applied in the performance of work, such as teamwork, decision making, and problem solving
Core Occupational & Technical	C-OTSS	· Basic occupational and technical knowledge and skills required for work performance across a broad range of occupations; core knowledge and skills include Environmental, Safety, Security, & Health, business policies and procedures, and manufacturing process
Specialty Occupational & Technical	S-OTSS	· The skills, knowledge, and performance unique to a specific job or occupation, subindustry, technology, or a specific apprenticeship program

A-7. Training Development Matrix

AMTTP Phase	Description	Skill Standards Reference	Learning Context
MEST	Criteria for high school or community college student entering MEST	AESS	· Course delivery environment (high school/ community college) · Competency-based delivery environment (student internship)
LTE Trainee	Criteria for hiring LTE with AS	C-OTSS S-OTSS (Level I)	· Competency-based delivery environment (mentorship)
Specific Trades Training	Criteria for hiring and retaining trades employee (FTE)	S-OTSS (Level 2)	· Customized training environment (SNL site specific training)

Albuquerque High School

Advanced Technology Academy

Advanced Manufacturing

| MACHINING & MATERIALS | ELECTRONICS |

9TH GRADE ACADEMY

English 9; Skills for Success; Math; Health; Biology; PE

↓

Language or Exploratory Metals
9th

Language or Exploratory Metals
9th

↓

10TH GRADE ACADEMY

English 10; Algebra or Geometry; Chemistry; Communication Skills

↓

Business Computer Applications -and- Computer Aided Drafting
10th

Business Computer Applications -and- Computer Aided Drafting
10th

↓

11TH GRADE ACADEMY

English 11; Algebra II; Physics; U.S. History

↓

Desktop/Web Publishing and Portfolio with Adv. Manufacturing
11th

Desktop/Web Publishing and Portfolio with Adv. Manufacturing
11th

↓

12TH GRADE ACADEMY

English 12; World History; Government\; Economics; Math

↓

Concurrent College Enrollment at TVI

Electives:

Lathe and Measurement; Blueprint 1; Milling; Support Machinery; CNC 1

Concurrent College Enrollment at TVI

Electives:
Electronics Fundamentals;
Intro to Technology;
Computer Applications;
Electronics Fundamentals DC Circuits;
Electronics Fundamentals AC Circuits;
Electronics Math; Digital Circuits;
Electromechanical Devices;

West Mesa High School

Advanced Technology Academy
Advanced Manufacturing

Standard Component ··

Grade 9	Grade 10	Grade 11	Grade 12
Algebra 1	Geometry	Algebra 2	Hon/Trig Statistics Hon. Math/Anal.
Science/Bio. English 9	Chemistry 1 English 10	Physics 1 English 1	Physics 2 English 12
P.E.** Health	Com. Skills	U.S. History	W. Hist. Econ./Gov

Technology Component ··

Grade 9	Grade 10	Grade 11	Grade 12
C.A.D. 1 Comp. Apps. 1 Metals 1	Mach. & Mat. 1 Comp. Apps. 2 C.A.D. 2 Metals 1...2	C.A.D. 3 Metals 1...2 Mach. & Mat. 2 Pre-Eng. Elec.	C.E.C.* Courses Concurrent Enroll At TVI* Articulated Courses At WMHS Other Tech. Courses Avail.

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A-9. Academic and Employability Skill Standards

Advanced Manufacturing Org 14100
(Based on the Manufacturing Skill Standards Council [MSSC] Skill Standards)
04/15/02   SAND2002-1128P

Work Area: **Student – Year One (S1) –** *(entry level criteria for student intern)*

EMPLOYABILITY

Category: *E-CAT001 ADAPTABILITY*

Knowledge:

- EKS-S1-01 Awareness to be agile in workplace dynamics, including flexibility, receptivity, and strategic thinking.

Skill to:

- EKS-S1-02 Accept constructive criticism.
- EKS-S1-03 Demonstrate and document consistently punctual arrival and regular attendance.
- EKS-S1-04 Demonstrate willingness to work.
- EKS-S1-05 Follow directions and procedures.

Category: *E-CAT002 CONSENSUS*

Knowledge:

- EKS-S1-06 Awareness of the foundations of team concepts, such as the awareness of techniques in avoiding arguments with personnel and dealing with confrontation.

Skill to:

- NA

Work Area: Student – Year One (S1) – *(entry level criteria for student intern)*

*Category: **E-CAT003 DECISIONS/JUDGEMENTS***

Knowledge:
- NA

Skill to:
- EKS-S1-07 Discern between right and wrong/good and bad.

*Category: **E-CAT004 GATHERING/ANALYZING INFORMATION***

Knowledge:
- EKS-S1-08 Knowledge of resources for gathering information, such as written materials, publications, people, Internet, library, etc.

Skill to:
- EKS-S1-09 Discern between what is fact and what is fiction.
- EKS-S1-10 Discriminate between information that is pertinent and relevant and information that is extraneous.

*Category: **E-CAT005 INFORMATION/COMMUNICATION TECHNOLOGY***

Knowledge:
- EKS-S1-11 Awareness of communications technologies, including usage of telephone, voice-mail, e-mail, Internet, and fax.

Skill to:
- EKS-S1-12 Correctly operate and handle computer storage media.
- EKS-S1-13 Demonstrate good computer skills, including creating, saving, storing, and retrieving data files; using directory structures; operating and adjusting computer peripherals; starting and exiting a software application; using menus and online help.
- EKS-S1-14 Demonstrate proper hardcopy and computer file management techniques.

Work Area: Student – Year One (S1) – *(entry level criteria for student intern)*

Category: **E-CAT006 LEADING**

Knowledge:
- EKS-S1-15 Awareness of the value of leadership qualities.

Skill to:
- EKS-S1-16 Recognize individuals in the position of authority.

Category: **E-CAT007 LISTENING**

Knowledge:
- EKS-S1-17 Awareness of the need to be attentive while someone is speaking.

Skill to:
- EKS-S1-18 Correctly interpret verbal communications and directions through the content and context of the message.
- EKS-S1-19 Follow verbal directions.
- EKS-S1-20 Use critical listening skills to correctly interpret meanings.

Category: **E-CAT008 ORGANIZING/PLANNING**

Knowledge:
- EKS-S1-21 Awareness of setting and balancing priorities.

Skill to:
- EKS-S1-22 Organize one's workday, such as managing school, work, and personal time.

Category: **E-CAT009 SELF-DEVELOPMENT**

Knowledge:
- EKS-S1-23 Awareness of personal goal setting for academic and personal success.
- EKS-S1-24 Awareness of required work skills to perform one's job.

Skill to:
- N/A

Work Area: Student – Year One (S1) – *(entry level criteria for student intern)*

Category: E-CAT010 SOCIAL SKILLS

Knowledge:

- EKS-S1-25 Awareness of Corporate Code of Ethic and Business Conduct, including honesty, integrity, respect, trust, responsibility, and citizenship. *
- EKS-S1-26 Awareness of Sandia's EEO/AA policies. *
- EKS-S1-27 Awareness of Sandia/Corporate/ DOE diversity initiatives. *
- EKS-S1-28 Knowledge of the appropriate dress for successful employment. *
  (*Provided at SNL New Hire Sign-In)

Skill to:

- EKS-S1-29 Act in a polite and respectful way towards co-workers.
- EKS-S1-30 Get along with peers.

Category: E-CAT011 SOLVING PROBLEMS

Knowledge:

- EKS-S1-31 Knowledge to seek help to answer questions or solve problems.

Skill to:

- EKS-S1-32 Recognize that a problem exists and take measures to mitigate the problem.

Category: E-CAT012 SPEAKING

Knowledge:

- EKS-S1-33 Knowledge of when to use casual vs. professional language.

Skill to:

- EKS-S1-34 Demonstrate good speaking characteristics, such as enunciation and articulation.
- EKS-S1-35 Use appropriate language, terminology, and tone of voice, as not to offend others.

Work Area: Student – Year One (S1) – *(entry level criteria for student intern)*

Category: E-CAT013 WORKING IN TEAMS

Knowledge:
- N/A

Skill to:
- EKS-S1-36   Demonstrate characteristics of a team player, such as working cooperatively and collaboratively with others to achieve goals and to produce positive work results.

ACADEMIC

Category: A-CAT001 MATHEMATICS

Knowledge:
- AKS-S1-01   Apply basic math functions, such as calculating percentages, rates, ratios, and proportions to solve problems with or without a calculator.

Skill to:
- AKS-S1-02   Add, subtract, multiply and divide four digit numbers, including fractions and decimals, with or without the use of a calculator.
- AKS-S1-03   Compute calculated measurements.
- AKS-S1-04   Compute within measurement systems, including converting between US and metric measurement systems, with a calculator.
- AKS-S1-05   Convert fractional measurements to decimal measurements.
- AKS-S1-06   Use basic measuring instruments, including scales, rulers, etc.

Category: A-CAT002 SCIENCE

Knowledge:
- AKS-S1-07   Knowledge of general science.

Skill to:
- NA

Work Area: Student – Year One (S1) – *(entry level criteria for student intern)*

Category: A-CAT003 READING

Knowledge:

- AKS-S1-08 Awareness of technical language.

Skill to:

- AKS-S1-10 Use and understand written information that may be presented in a variety of formats, such as text, tables, lists, figures, and diagrams.
- AKS-S1-09 Follow written directions, such as a list of steps or a checklist.

Category: A-CAT004 WRITING

Knowledge:

- AKS-S1-11 Knowledge of various writing mediums, such as handwritten, word-processing, e-mail, etc

Skill to:

- AKS-S1-12 Complete written forms, such as job applications, security clearance application, union forms, safety forms, etc.
- AKS-S1-13 Use English common language conventions of spelling, punctuation, grammar, and sentence and paragraph structure.

Work Area: Student – Year Two (S2) *(retention criteria for student intern continuance)*

EMPLOYABILITY

Category: E-CAT001 ADAPTABILITY

Knowledge:
- EKS-S2-01 Knowledge of the criteria to be promoted to the Student Year Two level, such as proficiency of Student Year One knowledge and skills.

Skill to:
- EKS-S2-02 Demonstrate willingness to learn new knowledge, skills, and behaviors.
- EKS-S2-03 Respond to constructive criticism in a productive manner.

Category: E-CAT002 CONSENSUS

Knowledge:
- EKS-S2-04 Knowledge to apply techniques to achieve consensus/agreement.
- EKS-S2-05 Awareness of the reporting hierarchy within the work environment, such as in getting consensus or approval for a project, in settling a dispute, etc.

Skill to:
- EKS-S2-06 Voice personal opinion in the appropriate language and manner as not to insult or offend others in a group work environment.

Category: E-CAT003 DECISIONS/JUDGEMENTS

Knowledge:
- EKS-S2-07 Awareness that judgements impact decisions.

Skill to:
- EKS-S2-08 Discern between good, better, and best / bad, worse, and worst.

Work Area: Student – Year Two (S2) *(retention criteria for student intern continuance)*

Category: *E-CAT004 GATHERING/ANALYZING INFORMATION*

Knowledge:

- EKS-S2-09 Awareness of internal and external resources specific to the workplace, such as vendor catalogues, Sandia's IRN, etc.
- EKS-S2-10 Awareness that good information is needed to make good decisions.

Skill to:

- EKS-S2-11 Make informed decisions, such as avoiding danger.

Category: *E-CAT005 INFORMATION/COMMUNICATION TECHNOLOGY*

Knowledge:

- EKS-S2-12 Awareness of Sandia's use of information systems and networks in manufacturing.
- EKS-S2-13 Knowledge of corporate information systems, such as electronic time cards, on-line training, on-line staff directory, etc.

Skill to:

- EKS-S2-14 Comply with Sandia's information and computer security policies.
- EKS-S2-15 Demonstrate appropriate and timely response to communications among co-workers using communications technologies, such as telephone, e-mail, voice mail, fax, etc.
- EKS-S2-39 Demonstrate proficiency in using Microsoft Office suite, including MS Word and MS Excel.

Category: *E-CAT006 LEADING*

Knowledge:

- N/A

Skill to:

- EKS-S2-16 Respect individuals in the position of authority.

Work Area: Student – Year Two (S2) *(retention criteria for student intern continuance)*

Category: E-CAT007 LISTENING

Knowledge:
- EKS-S2-17 Awareness of body language as a hidden means of communication.

Skill to:
- EKS-S2-18 Correctly comprehend and interpret basic technical terminology and language.
- EKS-S2-19 Frame relevant and pertinent questions to clarify what is heard.

Category: E-CAT008 ORGANIZING/PLANNING

Knowledge:
- EKS-S2-20 Awareness of one's own position within the structure of the organization and/or division (14000).
- EKS-S2-21 Understand the organizational reporting hierarchy for taking time off work, calling in sick, being late, etc.

Skill to:
- EKS-S2-22 Organize work area/work bench.
- EKS-S2-23 Plan basic work tasks.

Category: E-CAT009 SELF-DEVELOPMENT

Knowledge:
- EKS-S2-24 Awareness of one's own ability to be self-directed, such as learning new information/knowledge on one's own.

Skill to:
- EKS-S2-25 Demonstrate self-motivation in learning new information/knowledge on one's own.
- EKS-S2-26 Practice to achieve proficiency of work skills

Work Area: **Student – Year Two (S2)** *(retention criteria for student intern continuance)*

Category: **E-CAT010 SOCIAL SKILLS**

Knowledge:
- EKS-S2-27 Awareness that others may have a different social style than oneself.

Skill to:
- EKS-S2-28 Apply ethical practices in day to day interactions.
- EKS-S2-29 Respect social and cultural differences in others.

Category: **E-CAT011 SOLVING PROBLEMS**

Knowledge:
- EKS-S2-30 Knowledge to anticipate and identify problems.

Skill to:
- EKS-S2-31 Apply a system of problem solving.
- EKS-S2-32 Select resources for solving problems.

Category: **E-CAT012 SPEAKING**

Knowledge:
- EKS-S2-33 Awareness of public speaking and presentation techniques.
- EKS-S2-34 Knowledge of appropriate usage of technical terminology and professional language when speaking.

Skill:
- EKS-S2-35 Speak in a group environment in an appropriate manner.
- EKS-S2-36 Tailor verbal communication to the intended purpose and audience.

Category: **E-CAT013 WORKING IN TEAMS**

Knowledge:
- EKS-S2-37 Understand the role of a team as well as the role of an individual.

Skill to:
- EKS-S2-38 Learn from co-workers, such as sharing research results with co-workers.

Work Area: **Student – Year Two (S2)** *(retention criteria for student intern continuance)*

ACADEMIC

Category: A-CAT001 MATHEMATICS

Knowledge:

- AKS-S2-01 Knowledge of elementary algebra, including signed numbers, systems of equations and applications, linear equations, formulas, graphing, exponents and polynomials, rational expressions, factoring, and roots and radicals / quadratics.
- AKS-S2-02 Knowledge of the fundamentals of geometry, including spatial relationships and human factors.

Skill to:

- AKS-S2-03 Apply the principles of geometry in work tasks, including spatial relationships and human factors.
- AKS-S2-04 Calculate elementary algebraic equations, including solving linear equations and systems of equations and applications.
- AKS-S2-17 Create basic graphs and charts commonly used in manufacturing.

Category: A-CAT002 SCIENCE

Knowledge:

- AKS-S2-05 Knowledge of general chemistry and chemical reactions.
- AKS-S2-06 Knowledge of general laboratory procedures and safety.
- AKS-S2-07 Knowledge of general physics, including heat, sound, electricity, magnetics, and optics.
- AKS-S2-08 Understand scientific method, such as controlling an experiment.

Skill to:

- AKS-S2-09 Apply general scientific principles to perform work tasks.
- AKS-S2-10 Conduct elementary scientific experiments.

Category: A-CAT003 READING

Knowledge:

- AKS-S2-11 Knowledge of specific technical language/lingo.

Skill to:

- AKS-S2-12 Comprehend and interpret written technical information, such as formulas, specifications, graphs, and charts.
- AKS-S2-13 Follow written directions, such as procedures, manuals, etc.

Work Area: Student – Year Two (S2) *(retention criteria for student intern continuance)*

Category: A-CAT004 WRITING

Knowledge:

- AKS-S2-14   Knowledge of various writing formats, such as memos, reports, letters, etc.

Skill to:

- AKS-S2-15   Document quality control issues accurately and appropriately, such as problems or inconsistencies that occur during a work process.
- AKS-S2-16   Write up test/experiment results, change orders, or reports.

Work Area: LTE Trainee – Year One (L1) *(entry level criteria for Limited Term Employee Trainee)*

EMPLOYABILITY:

Category: E-CAT001 ADAPTABILITY

Knowledge:
- EKS-L1-01   Recognize the difference between a team working environment and an autonomous working environment.

Skill to:
- EKS-L1-02   Understand and meet employer expectations.

Category: E-CAT002 CONSENSUS

Knowledge:
- EKS-L1-03   Knowledge of union practices, procedures, and agreements.

Skill to:
- EKS-L1-04   Resolve conflicts, confrontations, and disagreements while maintaining productive working relationships.

Category: E-CAT003 DECISIONS/JUDGEMENT

Knowledge:
- EKS-L1-05   Awareness of decision making processes.

Skill to:
- EKS-L1-06   Demonstrate ethical business behavior, including honesty, integrity, respect, trust, responsibility, and citizenship.
- EKS-L1-07   Select and use relevant and good information to make decisions.

Work Area: LTE Trainee – Year One (L1) *(hiring criteria for Limited Term Employee Trainee)*

Category: E-CAT004 GATHERING/ANALYZING INFORMATION

Knowledge:
- EKS-L1-08   Knowledge of organizing information in preparation to analyzing and applying it.

Skill to:
- EKS-L1-09   Collect and analyze information to complete a simple work process.
- EKS-L1-10   Obtain facts, information, or data relevant to a particular problem, question, or issue through observation of events or situations, discussion with others, research, or retrieval from written or electronic sources.

Category: E-CAT005 INFORMATION/COMMUNICATION TECHNOLOGY

Knowledge:
- EKS-L1-11   Awareness of Sandia's on-line procurement process, such as Just-in-Time (JIT) ordering using Oracle or other communication technologies, such as telephone, fax, etc.

Skill to:
- N/A

Category: E-CAT006 LEADING

Knowledge:
- EKS-L1-12   Awareness of the characteristics of group leadership, including motivation, inspiration, and influencing of others toward effective individual or team work performance, goal attainment, and personal learning and development.

Skill to:
- EKS-L1-13   Discern between when to follow direction and when to provide direction.

Work Area: LTE Trainee – Year One (L1) *(hiring criteria for Limited Term Employee Trainee)*

Category: **E-CAT007 LISTENING**

Knowledge:
- EKS-L1-14   Awareness of individual differences in verbal communication in order to comprehend information, such as when working with different instructors or mentors.

Skill to:
- EKS-L1-15   Correctly comprehend and interpret verbal technical information to perform specific work tasks.

Category: **E-CAT008 ORGANIZING/PLANNING**

Knowledge:
- EKS-L1-16   Plan, organize, and structure work for effective job performance.

Skill to:
- EKS-L1-17   Create a project task plan.
- EKS-L1-18   Demonstrate good time management to include accurate and timely completion of tasks.

Category: **E-CAT009 SELF-DEVELOPMENT**

Knowledge:
- EKS-L1-19   Awareness of self and career development.

Skill to:
- EKS-L1-20   Pursue opportunities for one's own learning and development.

Category: **E-CAT010 SOCIAL SKILLS**

Knowledge:
- EKS-L1-21   Knowledge of developing, organizing, and supporting ideas in interpersonal business encounters, groups, teams, meetings, interviews, etc.

Skill to:
- EKS-L1-22   Establish interpersonal business relationships.

Work Area: LTE Trainee – Year One (L1) *(hiring criteria for Limited Term Employee Trainee)*

Category: E-CAT011 SOLVING PROBLEMS

Knowledge:

- N/A

Skill to:
- EKS-L1-23   Identify causes of some problems.

Category: E-CAT012 SPEAKING

Knowledge:

- N/A

Skill to:
- EKS-L1-24   Express ideas and facts verbally in a clear and understandable manner that sustains listener attention and interest.

Category: E-CAT013 WORKING IN TEAMS

Knowledge:

- EKS-L1-25   Awareness of principles of group dynamics.

Skill to:
- EKS-L1-26   Recognize the different working teams within 14100 center.

ACADEMIC:

Category: A-CAT001 MATHEMATICS

Knowledge:

- N/A

Skill to:
- AKS-L1-01   Apply mathematics principles in work tasks.

Work Area: LTE Trainee – Year One (L1) *(hiring criteria for Limited Term Employee Trainee)*

Category: E-CAT002 SCIENCE

Skill to:
- AKS-L1-02   Knowledge of chemicals and materials used in the workplace and their uses as applied to specific tasks.

Skill to:
- AKS-L1-03   Apply scientific principles, such as electricity and magnetics, to perform work tasks.

A-CAT003 READING

Knowledge:
- AKS-L1-04   Awareness of a variety of reading strategies.

Skill to:
- AKS-L1-05   Select reading strategies appropriate to the purpose, such as skimming for highlights, reading for detail, reading for meaning, and critical analysis.
- AKS-L1-06   Understand and use technical and scientific language.
- AKS-L1-07   Understand and use written information including schematics, manuals, parts lists, and detailed instructions.

Category: A-CAT004 WRITING

Knowledge:
- NA

Skill to:
- AKS-L1-08   Accurately format an e-mail message, including proofreading and editing prior to sending the message.
- AKS-L1-09   Accurately record incident reports according to Sandia or organizational procedures, such as ES&H (safety) / OSHA incidents.
- AKS-L1-10   Complete work orders, timecards, and just-in-time (JIT) purchasing forms.
- AKS-L1-11   Fill out a traveller.
- AKS-L1-12   Keep written track of results.

Please note that official distribution of these standards is to be through Carla M. Forrest. Photocopying is discouraged.

For information, questions, or additional copies of the Academic and Employability Skill Standards, please contact:

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Senior Corporate Training and Development Consultant
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Albuquerque, NM 87185-0653
Tel (505) 284-6255
Fax (505) 844-2748
Email <cmforre@sandia.gov>

A-10. Sandia National Laboratories Advanced Manufacturing Pipeline Program

SANDIA NATIONAL LABORATORIES ADVANCED MANUFACTURING PIPELINE PROGRAM

In Support of the

Critical Skills Development Program

Funded by the U.S. Department of Energy/Defense Programs (DOE/DP)

Dominique Foley Wilson

DOE/DP Education Pipeline Programs

Sandia National Laboratories

DP Complex Benefits

- Aligns with SNL Critical Skills Development Programs

- Meets 1999 Chiles Commission Report Recommendations

- Expands critical technologies/stockpile stewardship workforce

- Ensures retention of technology capabilities as existing workforce is reduced

- Ensures back-up approaches to existing technologies

- Leverages DP funds @ 3:1 ratio

Sandia National Laboratories

STUDENT BENEFITS

- Reduce drop-out rate

- Achieve academic excellence

- Integrate business community

- Experience cross-cultural integration

- Offer pathways for career options

- Involve parents

Sandia National Laboratories

SANDIA LEVERAGES VALUABLE RESOURCES

- **Multidisciplinary technology environment**
- **State-of-the-art technology capabilities**
- **DP departmental funding allocations**
- **Student internships**
- **Faculty externships**
- **Mentorships**
- **Guest lectures**
- **Conferences & workshops**
- **Professional & technical societies**

Sandia National Laboratories

SNL ACADEMIC & EMPLOYABILITY SKILLS STANDARDS

- **Align SNL training efforts in advanced manufacturing with Manufacturing Skills Standards Council (MSSC) recommendations**

- **List critical skills that are applicable to advanced manufacturing positions at SNL**

- **Provide a base for learning and training activities**

- **Provide a foundation for hiring criteria for student interns & SNL employees**

Sandia National Laboratories

AMTTP SKILLS STANDARDS

Knowledge & Skills

Academic & Employability Skills Standards
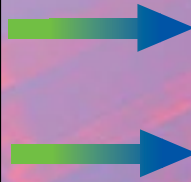
→ *Academic:* reading, writing, math, science

→ *Employability:* teamwork, decision-making, problem-solving

Occupational & Technical Skills Standards

→ *Core knowledge:* environmental, security, safety, health, business, manufacturing

→ *Specialty:* unique to specific job, technology, sub-industry, apprenticeship program

Sandia National Laboratories

ALBUQUERQUE PUBLIC SCHOOLS

- **Management, faculty, & administration buy-in**

- **Feeder schools**

WMHS

- Jimmy Carter Middle School
- John Adams Middle School
- Truman Middle School

AHS

- Jefferson Middle School
- Washington Middle School

Sandia National Laboratories

T-VI MANUFACTURING TECHNOLOGIES CURRICULUM

- **Offers associate degree & certificate options**

- **Addresses SNL trades requirements**

- **Aligns to national skills standards**

- **Ensures broad base of hands-on/heads-on skills**

  - Electronic technologies
  - Materials science
  - Semicon manufacturing

  - Photonics
  - MEMS
  - Testing & calibration

Sandia National Laboratories

SAN JUAN COLLEGE
Farmington, New Mexico

- **Associate of Applied Science - Semiconductor Manufacturing Technology:**
  - **Production operation**
  - **Equipment monitoring, adjustment & repair**

- **Machine Shop Technology Program**
  - **Machining**
  - **Tool & dye making**
  - **Mold making**
  - **Machine set-up and operation**
  - **Quality control analysis**

Sandia National Laboratories

LUNA COMMUNITY COLLEGE
Las Vegas, New Mexico

- **Associate of Applied Science - Advanced Mfg.**
  - Semiconductor manufacturing
  - Electro-mechanical systems
  - RF power
  - Computer use for technology

- **Associate of Applied Science - Electronics Eng.**
  - Microprocessor/interfacing
  - Digital electronic circuitry & applications
  - Telecommunications
  - Computer-aided design (CAD) graphics
  - Electro-mechanical fluid devices

- **Certificate: Electronics Technician**

Sandia National Laboratories

CENTRAL NEW MEXICO NEXT GENERATION ECONOMY INITIATIVE

- Growth strategy to create statewide comprehensive economic development

- Responsive to major NM institutions: SNL, UNM, AFRL

- Addresses common needs in workforce development

- Represents DOE investment to offset job losses at SNL & reduced regional procurement

- Implemented in partnership with business community, educational institutions, government-funded laboratories, & public interest groups

- Plan of action built around specific industry clusters

Sandia National Laboratories

CARL PERKINS PROJECT

- **Originated with Carl D. Perkins Vocational & Technical Education Act Amendments of 1998**

- **$5.2M awarded to T-VI over a 4-year period**

- **Support structures**
  - Core competencies
  - Employability skills
  - Career pathways
  - Economic development
  - Professional development
  - Women in high-wage careers

- **Career clusters**
  - Advanced Mfg.
  - Artisan Mfg.
  - Construction
  - Biotechnology
  - Info technology
  - Tourism & Hospitality

Carl Perkins web site: *http://planet.tvi.cc.nm.us/perkins/*

Sandia National Laboratories

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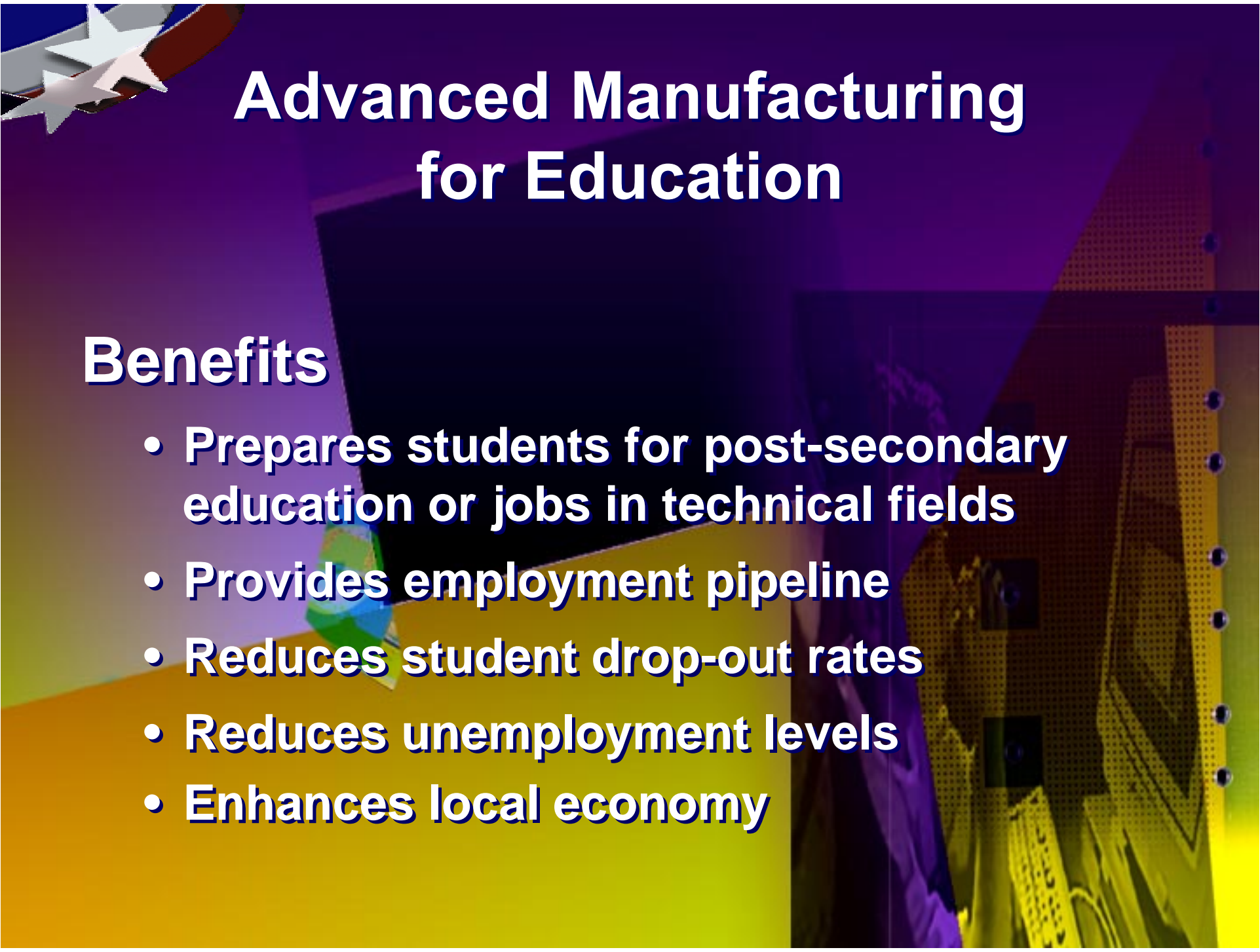
Sandia National Laboratories

Advanced Manufacturing for Education

Benefits

- Prepares students for post-secondary education or jobs in technical fields
- Provides employment pipeline
- Reduces student drop-out rates
- Reduces unemployment levels
- Enhances local economy

MEST PHASE

CO-OP Process

Enroll at TVI

May

| High School *Academy* | 2nd Year SNL Skills Training | **Sept** TVI Cert./Eng. | Limited Term Employee |

May 1st Year SNL Skills Training | **Sept** TVI Cert./Eng. | **May** 3rd Year SNL Skills Training | Graduate
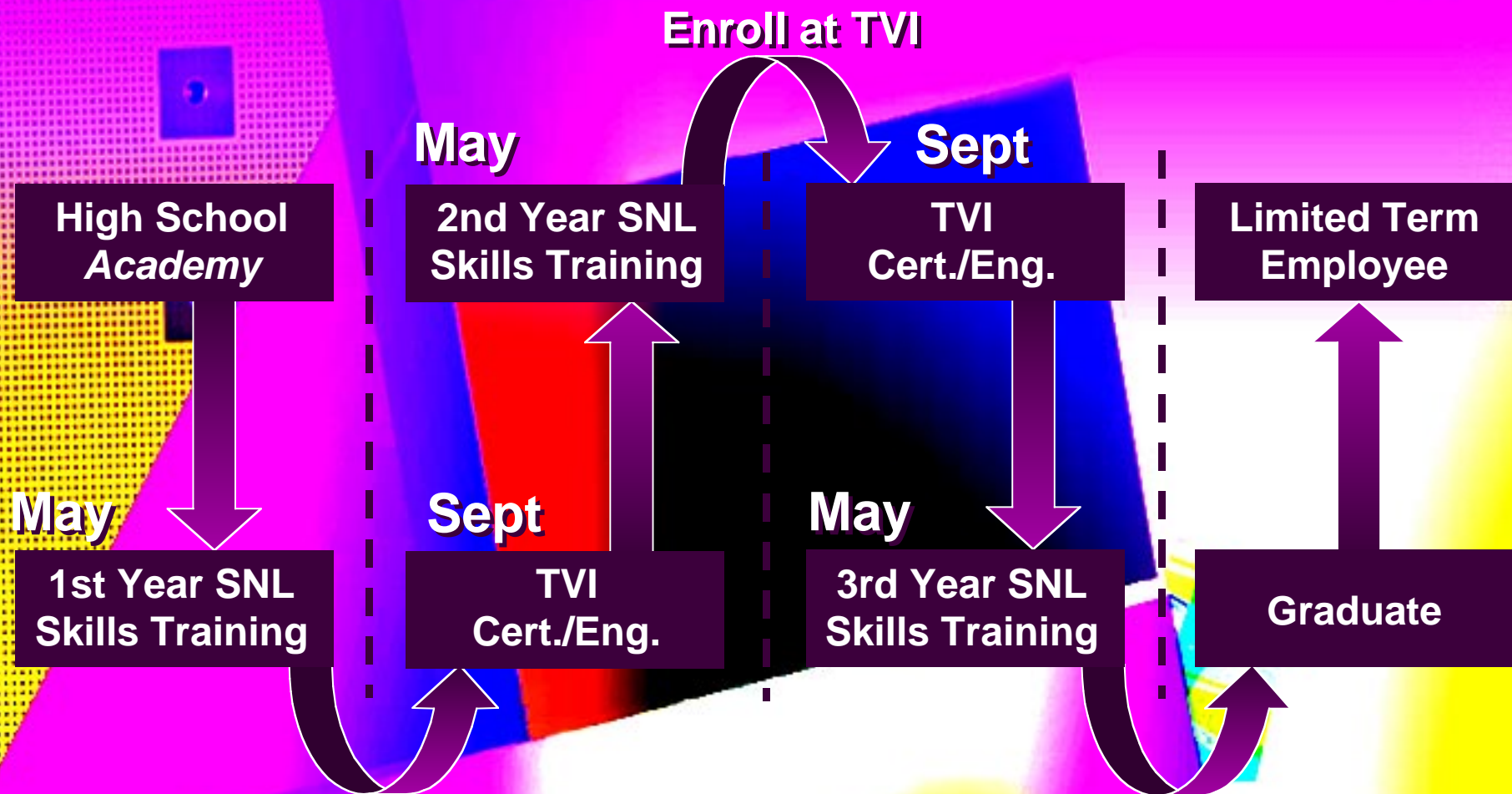
A-11. Sandia National Laboratories Advanced Manufacturing for Education

Sandia National Laboratories
Advanced Manufacturing for Education

June 1999

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Contents

Executive Summary

Sandia National Laboratories has a critical need for an appropriately trained workforce to meet its national security mission. To address that need, Sandia has developed several programs to support the pipeline of students from high school through graduate school. One such program is the Advanced Manufacturing for Education Program, which focuses on high school students. The program is being piloted at West Mesa High School—where it is known as the Advanced Technology Academy—and is in its third year. Six students and six staff from the Academy met on May 4, 1999 to discuss their perspective on the program's goals, strengths, and areas of improvement. The group identified and ranked a set of eight elements that they consider to be important to the success of this program.

The group agreed that the **goals of the program** are, broadly, fourfold. It supports the development of a trained workforce in the technology areas that will be of increasing need in the future—both for national security purposes and for international business competition. Secondly, the program focuses on those students who are in danger of not having a career focus or of dropping out, but who are interested and capable of taking on academic challenges. The third goal is that of broadening the existing school environment to make it more relevant to community needs and to students' futures. The final goal is to develop a program that can be a template for other high schools and can be extended to middle schools and to vocational/technical schools.

The tenor of the discussion was that this is a good program that will support students in taking responsibility for their future. The group agreed that the program is **appropriate for federal funding** because it supports development of a trained workforce in areas of national security needs, it nurtures a better informed citizenry, and because it is readily portable to school districts throughout the country.

Through discussion, the group agreed that the following eight **program elements** are important to the success of this program. The elements are presented in the relative order of importance as determined through combining individual participant's rankings of the elements.
- ➢ motivated students
- ➢ parent and community involvement
- ➢ personnel
- ➢ computer software and hardware
- ➢ communication
- ➢ financial support
- ➢ network of academic tutors, mentors, and related programs
- ➢ Academy identity and reward structure

The group agreed that the most important element to the success of this program is **motivated students**. This element includes both motivating students to take on challenges, starting as early as possible, and at the same time having motivated students to succeed in the program.

Parent support was identified as being of critical importance to students' motivation to succeed, and **community involvement** as important for identification of necessary workplace skills.

The right **personnel**—students, teachers, and staff—who understand the importance of this program and who are willing to go out of their way to make it work are necessary.

The technology focus of the program means that **computer** software and hardware is essential, as is compatibility of the equipment with that being used by community businesses, and the availability of effective training on that equipment.

Good **communication** among all involved parties, including students, teachers, staff, parents, and community technology organizations is critical.

Financial support for the program is necessary and can involve both the community and the students as well as the school district.

A support **network of academic tutors, of professional mentors, and of interactions with related programs and groups** would strengthen the program and assist students.

The program also needs a **strong identity and reward structure** to set it apart as a special program of achievement.

In conclusion, the group felt the program to be effective in supporting future workforce needs in national security areas related to technology and advanced manufacturing. The issues identified by the group as needing improvement tended to be related to the need for improved communication among all of the involved parties—students, teachers, staff, parents, and the community. The group agreed that the issues identified probably resulted in large part because the program is still new and most of the effort so far has been in putting the program into place. It was agreed that effort now must be put into refining the program. Specific recommendations included:

1. Develop communication mechanisms to ensure that all members of the Academy network are appropriately included, and to provide for adequate feedback. The communication network should include staff, teachers, students, parents, and the technology community.
2. Clarify, communicate, and maintain the criteria for acceptance into the program.
3. Consider involving Academy students as recruiters for the program at the middle school level.
4. Consider how to increase the personal or one-on-one time that students have with adults through the Academy. Some possibilities:
   ➢ Decrease class size.
   ➢ Provide access to tutors, either from the school staff, or through volunteers from Sandia or other technology organizations.
   ➢ Explore the possibility of mentors for each of the Academy students who want one, specifically a professional mentor from Sandia or another technology organization who is willing to correspond via email, to supervise projects, and/or to sponsor a student for a day in the work place.
5. Explore the possibility of having technical staff from Sandia or other technical organizations meet with teachers, staff, and students:

> To provide training in specific technical skill areas.
> To sponsor a career day to discuss what they do and to answer questions about what skills (of all types) are needed.

6. Explore intern programs at Sandia and other technical organizations to see what options may be useful in the Academy. An example is the professional etiquette class offered by Sandia to its summer interns.

7. Provide opportunities for parents to be involved in the Academy. Some suggestions:
   > Initial interviews between parents/students and teachers/staff as part of acceptance into the program.
   > Open-house activities during each school semester to allow students to show their parents what they are doing.

8. Examine other programs with similar objectives for possible joint interaction or fundraising opportunities.

9. Review the program for ideas to highlight Academy identity within the school and in the community.

National Security Workforce Requirements

Sandia National Laboratories plays a critical national security role in stockpile stewardship, which requires a workforce trained in scientific and technical areas. Recruitment of this workforce is becoming more and more difficult. The national unemployment rate of those with degrees in chemical, electrical, and mechanical engineering, or in mathematics or computer science is between 0.9 and 1.4 percent, compared to the overall unemployment rate of about 5%[1]. This shortage of available individuals is compounded by the low level of awareness of the national laboratories as an attractive employer. In a report to the Congress and Secretary of Energy the Commission on Maintaining United States Nuclear Weapons Expertise noted that "undergraduates in the engineering and information technology fields are no longer knowledgeable of DOE laboratories and production facilities."[2] The pressing national security need to attract a qualified labor force combined with the low level of awareness of the employment opportunities at the laboratories has prompted Sandia and other DOE facilities to support the development of a "pipeline" of appropriately trained students from the schools directly to the labs. These programs are designed to raise students' awareness of the national labs and their activities and employment opportunities. They also allow the labs to influence the development of curricula to meet their workforce needs. Finally, they encourage students to enter these fields, and provide a mechanism for the labs to identify and encourage promising students. The Advanced Manufacturing for Education (AME) program is one such tool that is focused on the early stages of the pipeline—at the high school level. Sandia is also involved in programs to support the workforce pipeline at the two-year, four-year, and graduate levels.

The Advanced Manufacturing for Education program was developed by Sandia to directly support training of a workforce in emerging areas of agile manufacturing. In discharge of its national security mission (including, for example, the production of neutron generators) Sandia has been at the forefront of a national trend in manufacturing, which is moving from conventional manufacturing techniques to a system of agile manufacturing that incorporates concurrent design and small-lot engineering. Students knowledgeable in these areas will be in demand in private sector as well as at the labs.

The AME program's purpose is to actively engage high school students in science and technology to establish this pool of qualified and interested technicians and technologists from which the labs can draw. Criteria for the program were developed by Sandia in direct consultation with Albuquerque Public Schools, a local high school, and the Center for Occupational Research & Development. In addition, input was received from Intel, Phillips Lab, Motorola, Abba Technologies, Silicon Graphics, and the SNL Advanced Manufacturing Center. Sandia line organizations that were experiencing attrition and an aging workforce were directly involved, and SNL core competencies as well as the types of equipment and faculty available in the schools were considered.

AME prepares students to pursue employment, or to pursue further education at a technical/vocational, two-year, or four-year college. Although open to students who would have

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[1] Bureau of Labor Statistics, November 1998 data.

[2] *Report of the Commission on Maintaining United States Nuclear Weapons Expertise.* Report to the Congress and Secretary of Energy. Pursuant to the National Defense Authorization Acts of 1997 and 1998. March 1, 1999. P. 10.

chosen such a career anyway, the focus of the program is on engaging the large group of students that are in danger of not having an academic focus and of dropping out of school. The program is designed to benefit Sandia by preparing students in Sandia's areas of need, and to benefit students by providing a pathway to careers for which there will be a strong demand.

Advanced Manufacturing for Education

The four-year program is being piloted at West Mesa High School in Albuquerque, New Mexico, and is in its third year. Three students from the program have interned at Sandia so far. In the 1998-99 school year, there were 29 students in the program. The 1999-2000 class, the first class that will have students to go through four full years, has almost 40 enrolled students. Students and staff at West Mesa call the program the Advanced Technology Academy (hereafter, the Academy). Students in the program will be tracked and offered internship opportunities in their junior and senior years, when they are old enough to legally work and have received initial academic training.

> *The emphasis of the discussion was as much on supporting an environment in which each student can take on the responsibility for his or her future as on how to help students to focus on a technology career.*

On May 4, 1999, a group of six students, and six teachers, administrative staff, and counselors met to discuss the program. Discussion focused on the program's goals, areas in which it could be strengthened, and the elements necessary to the success of the program. A list of attendees is included at the end of this document.

Vital Issues Process

The format for the meeting was the Vital Issues process[3] (VIp), a method developed at Sandia National Laboratories for articulating qualitative issues and deriving a quantitative ranking of those issues. The VIp has been in use for eight years with more than 50 groups and has been a successful tool in developing consensus among participants on issues and solutions.

The participants were asked to discuss the program, its goals, and the elements necessary to the success of the program. As an integral part of the discussion, participants identified specific areas (pros and cons) that they felt affect the program. This discussion was then used to focus on the elements that the group considered to be important to the success of the program. As part of the process, the group identified and agreed on a final list of elements necessary to the success of the program. At the end of the discussion, each member of the group ranked each of the program elements against each of the other elements using a pair-wise comparison process. The individual rankings were combined after the meeting to develop a group ranking of the importance of the elements relative to each other.

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[3] For more information on the VIp process, refer to: Engi, Dennis and Glicken, Jessica, May 1995, The Vital Issues Process: Strategic Planning for a Changing World, Sandia National Laboratories, SAND95-0845 UC-900.

Program Goals

The group discussed their understanding of the goals of the Academy at West Mesa High School. Prominent among these goals is providing for the future staffing needs of Sandia and of other technology businesses[4] located in and near Albuquerque. In addition, and interrelated, the group identified the two goals of engaging students who might otherwise drop out, and creating new technology-focused pathways of learning within the existing school environment. The group also agreed that the program will provide a model that can be used at other schools. Finally, the group briefly addressed why the use of taxpayer funds for a program of this type is appropriate.

Support development of technically trained staff for Sandia and other technology businesses in Albuquerque. Sandia, as is much of US manufacturing industry, is in the process of converting to advanced manufacturing technologies. The group sees this program as supporting the training of technical staff for Sandia as well as other technology businesses in Albuquerque.

Reduce dropout rate. The message from the students was clear—this type of program clarifies opportunities where few or none seemed to exist before. Another statement made by the students was that this program is proof that the community really does care about the students about supporting them and assisting them in making life decisions. The students talked about this

> *"Kids just need a chance. If you give kids a track, a direction, they will take it."*

program as providing a concrete and focused alternative to dropping out of school and providing the stability and structure that may not otherwise be there for some students.

The program targets the broad range of students that are not necessarily college-bound and that do not have a career focus, but that are motivated if given a focus. Through participating in the program, students gain a greater sense of the options that are available to them, and so may become interested in college where they were not interested before or in careers that they would not have previously considered. By providing a career path, it gives students a direction or motivation and provides schoolwork experience.

> *This program helps to clarify what technology businesses want in employees, and the work and social skills that students need to succeed.*

Create technology-focused pathways of learning within the school environment. It was noted that the Academy program is working within the established school curriculum to make it more relevant to community (and Sandia) needs and to students' futures. This increased breadth of experience in high school better prepares students for employment, for vocational or technical training, or for college. The Academy brings businesses and schools together to teach students

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[4] The term "technology businesses" is used here in a broad sense to indicate any business or organization that uses advanced technology or produces items that embody advanced technology.

what they need to succeed in the working world (including work, dress, behavior, and social skills) and helps students define a viable direction and career focus.

Develop a template for other schools. The group agreed that this program would be a good template for use in other schools, and that it can be extended to middle schools and to vocational and technical schools once it has been refined.

Appropriate for Taxpayer Funding.
The consensus of the group was that funding for a program of this type is appropriate for taxpayer funding because it is an investment in the future of the nation and it has applicability in school districts throughout the nation. The program provides a focus for training the future workforce, targets a much broader spectrum of

> *This program is an investment in this community's future, and is portable to other areas.*

students than just the college-bound, and clarifies the opportunities for students in skill areas related to technical fields. The program provides a return on investment in a larger trained and informed workforce, in a reduced dropout rate, and in a better-informed citizenry.

Program Elements

The discussion by the group started at the general level and became more specific, ending in identification by the group of eight elements that they consider to be important to the success of the program. The eight elements, listed below, grew out of the earlier discussion and that material is included in the appropriate discussions of the elements. The group agreed that this is a good program and that it can achieve the previously identified goals. The discussion tended to focus on how to make the program stronger and more effective. The following program elements include both existing elements in the current program as well as suggestions for new elements.

- ❖ Motivated Students
- ❖ Parent and Community Involvement
- ❖ Personnel
- ❖ Computers
- ❖ Communication
- ❖ Financial Support for the Program
- ❖ Tutors/Mentors/Network
- ❖ Academy Identity/Reward Structure

Motivated Students

Discussion throughout the meeting addressed the need both for motivating students to take on challenges, and the need for motivated students who are able to accept and succeed when faced with challenges.

Creating Motivated Students.

One strong message to come out of this meeting was the need to understand that many of the students targeted by the program don't have a direction or the perception that options are available. By providing information about real job opportunities, and a path to get to those opportunities, the Academy provides students with a "map" to what might otherwise appear to be uncharted territory. This "map" to real-world job opportunities can play an important role in motivating students to take on academic challenges.

> *"We need motivated students, students who are actively involved in mapping their future, but who do not necessarily have an accurate map."*

A related aspect to creating motivated students is the need to treat students with respect, to show that they are valued and that they are an important part of the community and the program. One participant noted that this means finding an equilibrium between treating each other with respect and behaving with appropriate deference to legitimate authority.

It was clear that the group felt that the effort to motivate students must start earlier than high school, at least in middle school and preferably earlier. Related to this was a student suggestion that Academy students could recruit at middle schools for the Academy.

Need for Motivated Students in the Program

In addition to the need to motivate students in general, it was pointed out that the program itself needs motivated students. The greatest amount of discussion regarding this factor was about the need to have students in the program who are prepared and interested. The discussion suggested that the acceptance criteria for the program have not been clearly stated or adhered to and that the result is that

> *Students who are not prepared academically, or interested in the Program, affect the morale of the entire class.*

there have been students admitted who had failed the prerequisite math and science classes. Several attendees noted that the presence of these students affects the morale of students and teachers in the program, and the ability of the class as a whole to complete the academic requirements of the course. The group agreed on the need to review and clarify the criteria for acceptance into the program, to clearly communicate those criteria to everyone involved, and then to adhere to those criteria.

It was also suggested that greater diversity in the classes and smaller class size would improve the interaction in the classroom. In particular, smaller class size (the standard in the school is now 32 students per class) would allow more personal student/teacher interaction, thus affecting student motivation.

Parent and Community Involvement

Closely related to motivating students is the need to have a community that supports and values the students and their efforts. The most important components of that community being the parents of the Academy students and the technology businesses in Albuquerque.

Parent Involvement

The group was clear that when parents are involved it positively affects student behavior, attendance, and motivation to succeed. Parent involvement has been planned as part of the Academy program, but the group agreed that it needs to be more strongly emphasized and purposefully carried out. It was generally agreed that the fact that this has not been done is largely due to the fact that the program is still new and that until now most of the effort has

> *"If you get kids together who are prepared and with similar interests then the program will take off, especially if parents are involved."*

gone into getting the Academy up and running. Two specific suggestions were made to enhance parent involvement. The Academy could have an open house at least once a quarter to invite parents into the classroom to allow students to explain to their parents what they are learning. The second suggestion was to invite parents to attend an initial introductory meeting with teachers and staff when their children become involved in the program.

Community Involvement

> *The community needs to be involved in the Academy and the Academy in the community.*

In this context, the technology businesses that have a need for a technically trained workforce are the "community" of concern. The group discussed the value to the program in extending the community beyond Sandia to other technology businesses. The community is important to the program in several ways.

It was strongly suggested that having technical representatives come to the Academy to discuss possible careers and desired job skills would be of great help to teachers and administrators as they plan the course work. Specifically mentioned during discussion was the need to have employers discuss all job skills in which they have a need, from the technical skills to the business and social skills. On hearing about a professional etiquette class offered by Sandia to college-level interns, there was general interest in having that class offered to seniors as part of the Academy program.

It was also suggested that direct involvement in the Academy by technical representatives of the community would both strengthen the program and motivate students. Some of the specific avenues for direct involvement in the program include coming into the classroom to provide some training, or making available technical projects to complete in class-time. In addition, the Academy would benefit from financial support from local businesses, for example through provision of equipment (see section below on computers) as well as from access to internships or work-study projects for students.

Students noted the need to raise the awareness of the community about the Academy and suggested ways for the Academy to be involved in the community, including doing a mural as part of an anti-graffiti campaign or creating web pages for businesses in town.

Personnel

The group included in this element all of those people who are immediately necessary to success of the program including administrative staff, teachers, and students. The point was made that the Academy requires more work and involvement by teachers in turn requiring teachers that are willing to make the extra

> *It's important that students, teachers and staff understand the importance and goals of the Academy, and are willing to go the extra mile. It's important that everyone be treated with respect.*

commitment. In this vein, it was noted that students are responsible for their own success, for meeting deadlines, and for appropriate behavior.

There have been some personnel issues related to getting a certified teacher for the computer-aided design class; however this issue is being resolved. The larger problem in this area seems to be related to communication among all of those involved, in particular the students and teachers. The discussion later regarding communication is directly relevant to this element.

One specific area that was noted as needing more focus is more explicit support from the school's administration for teachers—including more clearly defined criteria for student placement in the program, stronger integration of the various parts of the program, better communication of the program goals, and maintenance of the standards/expectations of the program.

Computers

The computer lab currently has three different levels of computers and two versions of software. It would be of benefit to the students to have consistent hardware/software, both within the lab, and with Sandia and other businesses for which the students might work. In addition, there is a need for additional equipment including surge protectors and printers, as well as sufficient computer memory to be able to perform the work necessary

The lab also needs to be networked, both internally and with others (for example, with Sandia to allow students to do projects in their junior and senior year under advisement from Sandia). It would be helpful to have a Sandian come to the school to do some training on use of the computers.

> *The Academy needs computer hardware and software that is compatible within the school and with technology organizations outside of the school.*

One student suggested that the Academy look at how to get equipment available to students in their homes.

Communication

> *The Academy needs to focus on developing clear communication paths among all of the students, teachers, staff, parents, and the community.*

The group agreed that mechanisms need to be in place to allow all of the personnel involved to get and give effective feedback and to appropriately involve parents and the larger business community. In addition to making the lines of communication clear, the Academy needs to ensure that mechanisms are in place to deal with needs problems and issues as they arise.

The need for improved communication (and consistent follow-through) arose repeatedly

throughout the overall conversation. In fact, this element cuts across the rest of the elements. Identifying it separately, however, underscores its importance to the program's effectiveness. Some examples of how this element affects the other elements:

> Providing students with a forum to articulate their views and needs and to provide feedback, and taking that information seriously relates to the earlier discussion about motivating students.
> Keeping teachers informed and involved in planning is related to the need to support teachers in the program.
> Community involvement in program planning and development is important to make the program relevant to job needs.
> Communication with and feedback from parents is critical to motivating students.

The group concurred that the issues related to communication need to be addressed as part of the ongoing refinement of the program. In addition to general review of the communication within the program, the following specific suggestions were made:

> Review specific teacher needs to support their effectiveness in accomplishing program goals.
> Investigate staff training to improve program communication.
> Enhance continuity of knowledge and interest by assigning one counselor to the Academy students that they keep for their entire time in the program.

Financial Support

Financial support from within the school and from the community is important to the success of the program. Students can play a role in obtaining financial support.

The group recognized the important role that financial support will play in the success of this program. The importance of in-kind financial assistance from Sandia and other businesses in the form of software and equipment, or training assistance for both teachers and students with that software and equipment, was mentioned. In addition, it was noted that these organizations can provide valuable support through sponsorship of other activities such as mentoring relationships, meetings, or of items such as circuit boards to be assembled by students as part of student fairs or competitions.

The discussion of this element included not just the need for financial support from community organizations, but also a role for student involvement and participation in fundraising. Suggested student-led fundraising activities included designing web pages for businesses as well as more traditional activities such as car washes. Finally, the suggestion was made that networking with other programs with similar goals (for example, the school to careers program) would potentially allow the groups to leverage available funds to gain a broader benefit.

Tutors/Mentors/Network

This element includes three factors that arose in discussion—the need for academic tutors, involvement by mentors from the business community with individual students, and interaction with other related programs. These three factors would provide the components to add another layer of support (beyond teachers and administrative staff) for students in the program.

> *Tutors, mentors, and networking with other similar programs would provide a support structure for the students in the program.*

Academic tutors in classes

Academic tutors in the areas encompassed by the program would benefit the students who need additional assistance with their course work. Tutors could include volunteers from Sandia or other technology businesses that would be willing to tutor in specific areas, in addition to teachers from the school.

Professional Mentors

The group as a whole felt that professional mentors from the technical staff at Sandia or other local technology businesses would benefit the students and strengthen the program. Mentors play an important role in introducing students to new career opportunities and in providing professional support to students as they face challenges in the program. Mentoring could occur in person or via email. A specific opportunity that would be of benefit to students would be the ability to accompany their mentor to work one day a semester in order to be exposed to technology and to expectations in the work world. Along these lines, it was also suggested that having a Sandian or other business representative meet with the students about potential technology job opportunities and expectations would be beneficial.

Network with Related Programs

There are existing programs that have similar or related objectives; for example math and science clubs, both at the middle school and high school level. The group suggested the value of looking at other existing programs to identify possibilities for joining together for specific events (for example a science fair, or for fundraising activities) for the purpose of creating a network of related programs. Such networking might allow for leveraging of funds and resources as well as opportunities for strengthening each program. It was also noted that networking with programs that start earlier in the students' career, for example, in middle school, is a method of increasing others' awareness of the Academy program at an earlier stage and of recruiting for the program from middle school students.

Academy Identity/Reward Structure

The group concurred that creating the identity of the Academy as a program is important to motivating students and to focusing energy and resources to meet specific goals. The program has been well thought out and planned, and works within the existing curriculum but needs to do a better job of creating an "academic envelope" that identifies the Academy and its objectives. A specific suggestion about how to create a stronger Academy identity was to develop a reward structure to reward the completion of different stages of the program. This might include special opportunities such as an Academy Fair in which students are allowed to show projects they have completed, or are given time to work on special projects. In addition, the Academy could sponsor a wall in the school and have T-shirts and a logo.

> *The Academy needs to create a stronger identity, in the school and the community.*

Ranking of Program Elements

Each of the participants ranked each of the program elements against each of the other program elements regarding their importance to the overall experience of the program. The results were combined after the meeting to provide an overall group ranking of the importance of each element relative to the others. The standard deviation of each group ranking was also calculated to get a measure of the overall disagreement between the individual rankings of each program element and the overall group ranking. The overall group ranking or mean for each program element is shown, along with a bar of one-half standard deviation on each side of the mean, to indicate the level of disagreement, as measured by the standard deviation around the mean. The rankings are shown in Figure 1.
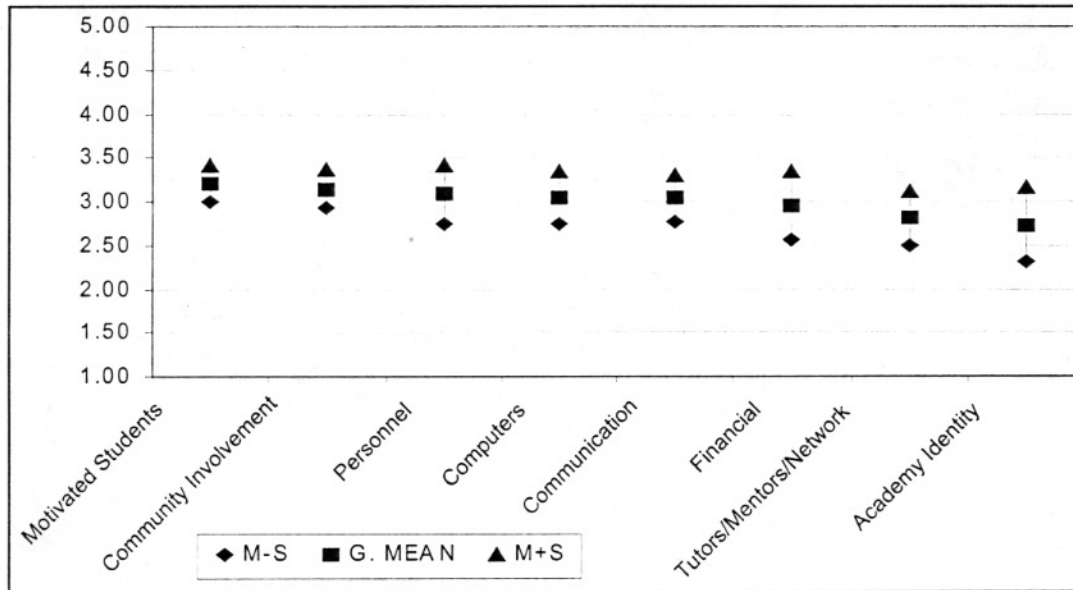

Figure 1. Ranking of Program Elements for the Advanced Manufacturing for Education (The Academy) Program

With a spread of only one-half point between the highest ranked element and the lowest ranked element, the group clearly felt all of these elements to be important to the success of the program. However, even given the closeness of the group rankings, some distinctions can be drawn. The group ranked motivated students as being of most importance to the success of the program. This ranking is consistent with the tone and content of the earlier group discussion, which returned consistently to the importance of supporting students as early as possible in identifying and focusing on opportunities for the future. Interestingly, this element also had the strongest agreement between individual rankings and the group ranking of all of the elements as measured by the standard deviation.

Motivated Students was followed closely by Parent and Community Involvement in importance to the success of the program. These two elements were, in turn, closely followed in importance by a group of three elements that were ranked so closely as to be equivalent in importance: Personnel, Computers, and Communication. Financial

Support, availability of Tutors/Mentors/and a Network, and creation of an Academy Identity followed in importance. The last element, Academy Identity, had the widest range of disagreement between the individual rankings and the final group ranking as to the element's importance to the program.

Summary

On May 4, 1999, a group of students, teachers, and staff involved in the Advanced Manufacturing for Education Program being piloted at West Mesa High School (where it is known as The Advanced Technology Academy) met to discuss the program. The group agreed that this is a good program that can be an important factor in encouraging students to follow technology careers, and in engaging students who might not otherwise have an academic focus or graduate from high school. The group also felt this program to be an effective use of federal funds as it addresses future workforce needs both for national security purposes and for US business, and because it is a template for use in other schools. As a result of their experience to date, the group identified a set of eight program elements that they consider important to the long-term success of the program. The group agreed that this is a good program, however, they also identified specific issues that need to be improved as part of the continuing evolution of the Academy at West Mesa High School. The following recommendations came out of the discussion and relate to strengthening the program.

Recommendations

1. Develop communication mechanisms to ensure that all members of the Academy network are appropriately included, and to provide for adequate feedback. The communication network should include staff, teachers, students, parents, and the technology community.
2. Clarify, communicate, and maintain the criteria for acceptance into the program.
3. Consider involving Academy students as recruiters for the program at the middle school level.
4. Consider how to increase the personal or one-on-one time that students have with adults through the Academy. Some possibilities:
   - Decrease class size.
   - Provide access to tutors, either from the school staff, or through volunteers from Sandia or other technology organizations.
   - Explore the possibility of mentors for each of the Academy students who want one, specifically a professional mentor from Sandia or another technology organization who is willing to correspond via email, to supervise projects, and/or to sponsor a student for a day in the work place.
5. Explore the possibility of having technical staff from Sandia or other technical organizations meet with teachers, staff , and students:
   - To provide training in specific technical skill areas.
   - To sponsor a career day to discuss what they do and to answer questions about what skills (of all types) are needed.
6. Explore intern programs at Sandia and other technical organizations to see what options may be useful in the Academy. An example is the professional etiquette class offered by Sandia to its summer interns.
7. Provide opportunities for parents to be involved in the Academy. Some suggestions:
   - Initial interviews as part of acceptance into the program.

➤ Open-house activities during each school semester to allow students to show their parents what they are doing.
8. Examine other programs with similar objectives for possible joint interaction or fundraising opportunities.
9. Review the program for ideas to highlight Academy identity within the school and in the community.

Conclusion

The Academy has as its purpose engaging students in technology oriented careers to meet the nation's future need for a technologically trained workforce. This group of students, teachers, and staff concurred that the program, although new, promises to achieve this goal. The thoughtful and substantive involvement of the students in this program evaluation speaks to their engagement in the program. Staff and teachers in the meeting represented a breadth of experience, in both length of time in the education field as well as in areas of expertise. Their positive perspective on the program speaks to its potential viability as an education tool. The presence in the group of a high-level member of the administration, a Vice-Principal, is an indication of the beneficial potential that the school sees for this program. While clear that there were specific issues that caused rough spots in the program it was also clear that there was a willingness to examine and address those issues. At the same time that the technology focus of the program was clear, the tenor of the discussion was that of creating an atmosphere to allow students to be responsible for their future.

Attendees

Baca, Essel – Vice Principal
Beserra, Pat - Counselor
Castrellon   , Hector – Student
Contreras, Santos – Student
Cordova, Mary Jane – Student
Daly, Tom – Teacher and Academy Coordinator
Jackson, Bonnie - Technology Coordinator
Martinez, Erik - Student
McKenna, Shan – Student
Salazar, Dominic – Student
Scott, Kathy – Counselor
Torres, Tim – Teacher

A-12. West Mesa High School Advanced Technology Academy

West Mesa High School
Advanced Technology Academy

Program:

Advanced Manufacturing for Education

Description:

West Mesa High School is initiating an exciting new program for students with an interest in technology. The Advanced Technology Academy offers a comprehensive curriculum approach that presents the graduate with a variety of options. Upon completion, a student can opt to pursue a bachelor's degree at a 4-year institution, an associate's degree at a technical school/community college, or employment as a technologist / technician.

This program encourages students to work with their counselors to build a 4-year plan which includes courses in communications skills, computer application, trades and technology (metals, woods, automotive, and Computer Aided Drafting), and conceptual algebra (ADP). Students will emerge with applicable technical skills that have been identified as meeting the requirements of local businesses, technical schools, and universities. *(Please see reverse side for further information.)*

This program is developed in partnership with Sandia National Laboratories and the Center for Occupational Research and Development.

Requirements:

Students with an active interest in a school-to-career approach (hands-on) to learning are encouraged to apply.
Math: General Math, Pre-Algebra, or Algebra I
GPA: 2.5 or higher

Contacts at WMHS:

Mr. Pat Beserra	831-6993 x116	Ms. Kathy King	831-6993 x149
Mr. Joe Robinson	831-6993x120	Ms. Jennifer Macdonald	831-6993x104
Ms. Bonnie Jackson	831-6993x124	Mr. Essel Baca	831-6993x105

Fold here and remove. RETURN WITH YOUR REGISTRATION CARD!

PARENT'S SIGNATURE _____ TELEPHONE #: _____

STUDENT'S NAME: _____ I.D. # _____

IF INTERESTED, PLEASE COMPLETE FOLLOWING INFORMATION:

West Mesa High School
Advanced Technology Academy

West Mesa High School
Advanced Technology Academy

	9	10	11	12
Math	*Algebra IA or I or ADP II	Geometry	Algebra II	Statistics
Science	Physical Science and/or Biology I	Chemistry in the Community or Chemistry I	Physics I or Principles of Technology I	Physics II or Principles of Technology II
English	Grammar, Literature, Applied Communications			
History Humanities Government Arts	Arts, Humanities, Social Science, History, Government			
Technology	Computer Applications	Machining & Materials Processing I (Metals I / Woods I)	Machining & Materials Processing II (Metals II)	Automotive & Transportation Technology II
	CAD I or Automotive & Transportation Technology I	Computer Aided Design II (CAD II)	CAD III & CAM	Manufacturing Technology (Projects)

*Counselor recommendation required; enrollment in Algebra IB or Algebra I in summer school

Drug Test
US Citizen
2.5 G.P.A.

developed.

A-13. Curriculum Articulation Agreement Associate Degree Programs

CURRICULUM ARTICULATION AGREEMENT
ASSOCIATE DEGREE PROGRAMS
BETWEEN
ALBUQUERQUE TVI TECHNOLOGIES DEPARTMENT
AND
ALBUQUERQUE PUBLIC SCHOOLS

This agreement made and entered into between the Albuquerque Technical Vocational Institute (hereinafter referred to as TVI) and the Albuquerque Public School district (hereinafter referred to as APS) will become effective on April 1, 1999.

Whereas, both institutions agree to participate in a program of Curriculum Articulation with the TVI Technologies Department. Articulation will be with the Design Drafting Engineering Technology Associate of Applied Science degree program. Specifically each participating APS High School will provide students with supporting courses and competency examinations for one or more of the following courses:

DDET 104L Introduction to Technical Drafting	4 credit hours
DDET 106L Basic CADD	3 credit hours

Whereas, both parties desire to reach an agreement for their separate and mutual responsibility:

TVI Will:
- Provide curriculum development support, curriculum, and competency examinations to APS High Schools that wish to participate.
- Provide a single point contact person for each course.
- Grant TVI credit for successful completion of the competency examination.

APS Will:
- Administer course competency examinations.
- Provide a course owner, to act as a single point contact to the TVI Technology's Department, program chairman for each of the courses that the participating High School agrees to articulate.
- Submit verification of student competency and a letter grade for each course to the TVI records office.

Students Will:
- Matriculate into one of TVI Technology department's Computing Technology Associate of Applied Science degree programs within (24) months of completing one or more of the pilot courses.
- Meet course prerequisites as stated in the TVI catalog.

Signatures:

Janice E. Micali   4-27-99
Vice President of Educational Services (TVI)   Date

Brad Allison   4-15-99
Superintendent (APS)   Date

                       4-27-99
Dean of Technologies (TVI)   Date

Leah J. Gutierrez   4/20/99
Curriculum Assistant Principal (APS)   Date

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<u>West Mesa High School</u>

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